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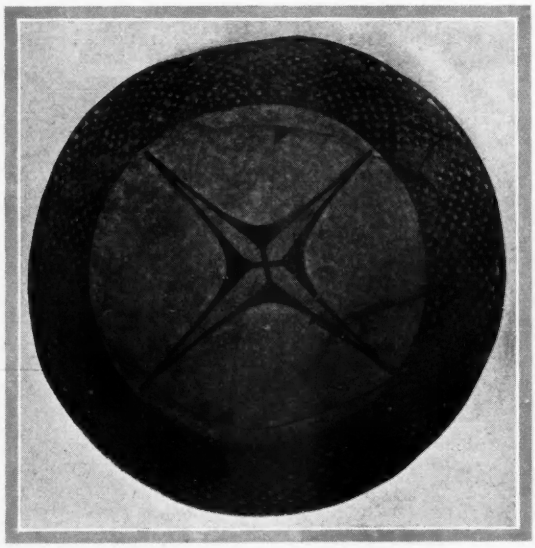

FROM IRAQ SIX THOUSAND YEARS AGO
(see page 361)

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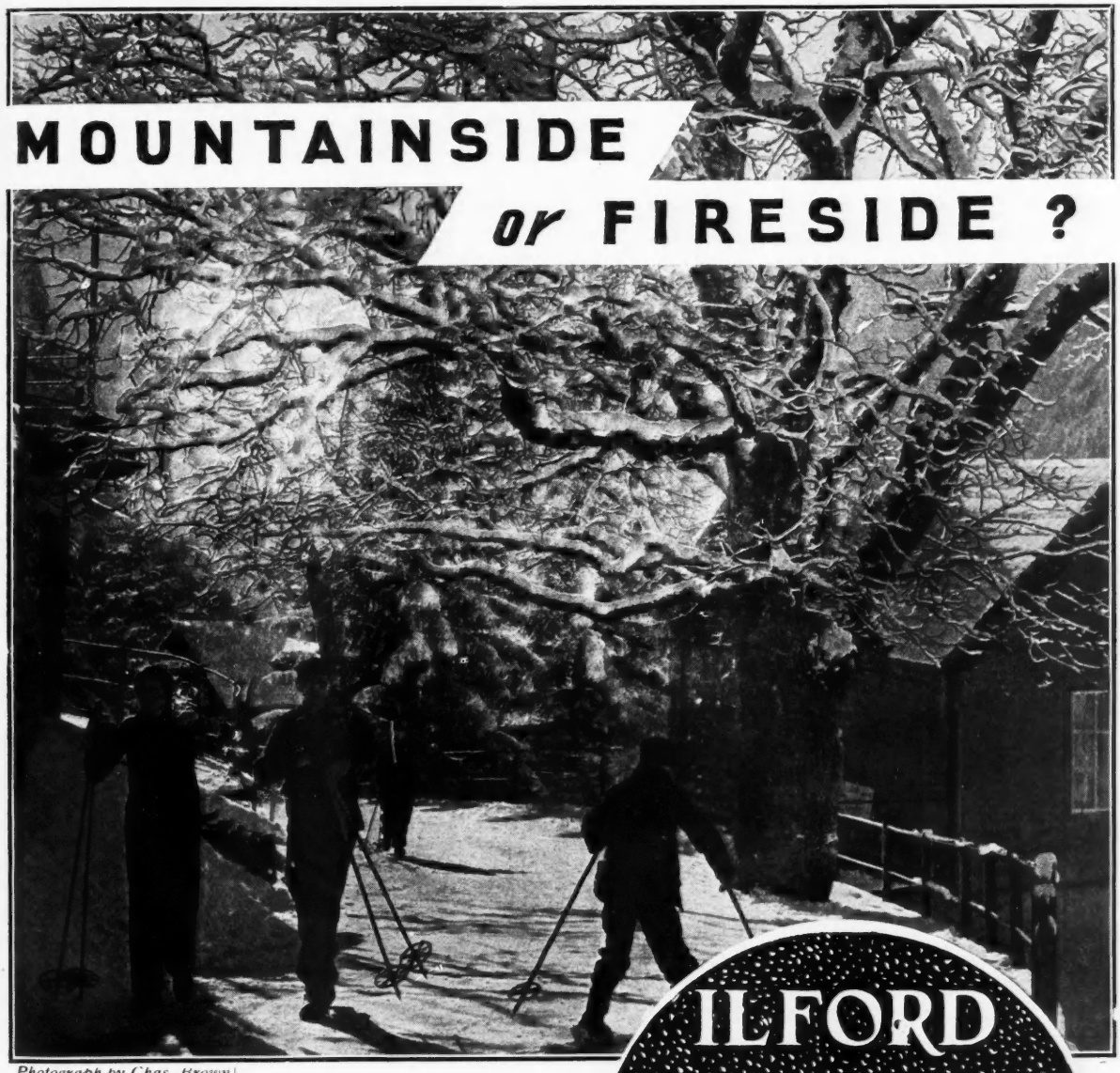

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Notes of the Month.

It is announced that an Anglo-American agreement has now been reached regarding a regular Transatlantic air service. Since the Atlantic was first crossed by air in 1919, the possibility of a permanent service has been fully explored, and many notable test flights have been made in aeroplane, seaplane and airship. The work of the British Arctic Air Route Expedition, led by the late Mr. H. G. Watkins, did much to pave the way for a possible route by way of the Arctic. Many difficulties have yet to be solved before a regular service can be established, but Mr. J. L. Nayler, who reviews the problems involved on another page, forsees the establishment of a permanent air mail within the next two or three years, shortly followed by a passenger and goods service. The former will probably be from Ireland to Newfoundland, while the Arctic air route may be used for the passenger route.

* * * * *

The British Radio Expedition to the Arctic Circle has succeeded in solving two important problems : It has discovered why wireless waves are frequently unable to cross the North Pole—which is necessary in many commercial communications—and it has studied the way in which the sun produces and controls the electrification in the upper layers of the atmosphere. The expedition formed part of the second International Polar Year. In describing the work to the Royal Institution, Professor E. V. Appleton showed records indicating that during magnetic storms, which frequently occur in Arctic latitudes, electrification at the lowest levels of the Heaviside Layer is increased to such an extent that wireless waves are completely absorbed in this region, so that the layers can play no part in reflecting them and thus helping them to travel great distances. There is a monthly sequence of intense magnetic activity when wireless waves are absorbed and not reflected by the upper atmosphere. The results of the expedition clearly indicate that if wireless is to be used in Polar exploration, note must be taken of this monthly period of unfavourable conditions.

* * * * *

There have apparently been acute differences of opinion among members of the Expedition regarding the constitution of the upper layers of the atmosphere. Some hold that electrification is due to the ultra-violet light of the sun, the other that it is due to bombardment of our atmosphere by streams of particles shot out from the sun. Professor Appleton considers that the results obtained show conclusively that the main cause of the electrification in both layers is the ultra-violet light of the sun, and in magnetically quiet conditions (no magnetic storms) this electrification is actually less in the Arctic regions than in England. This is to be expected on the ultra-violet light theory because of the flatter angle at which the sun's rays strike the earth near the Poles.

* * * * *

The recommendations of the International Conference for the Protection of the Fauna and Flora of Africa will be widely welcomed by nature lovers and real sportsmen alike. The conference was held in the House of Lords under the presidency of Lord Onslow and of special value are the recommendations regarding the hunting, filming and capture of wild beasts. Those who have seen some recent talking pictures of African wild life cannot fail to have been disgusted at the methods often employed to obtain " close-up " photographs. A draft convention drawn up by the British Government, and considered with approval by the Conference, prohibits the use of motor vehicles and aircraft for hunting, killing or capturing animals, or with the object of stampeding them for photographic and

film purposes. The Conference is to be commended for adopting a further provision prohibiting the surrounding of animals by fires for hunting purposes, and generally prohibiting wherever possible the use of poison, explosives, dazzling lights, flares, nets, pits, enclosures, traps or snares, or set guns and missiles containing explosives for hunting purposes. It is to be hoped that the recommendations of the Conference will be adopted by the governments concerned, and that the objectional methods adopted by a certain class of hunter and photographer will be vigorously put down.

* * * * *

Notable progress has lately been made in the production of food by chemical processes, particularly in Germany. At a meeting of chemical engineers in London Dr. Friedrich Bergius, well known as the inventor of the process of hydrogenating tar and coal, said that sugar can now be produced from wood on a commercial basis. The raw sugar is equal in nutritive value to barley flour. He points out that in countries where wood is obtainable in large quantities, wood sugar can be produced at a lower price than cane sugar is produced in the countries in the torrid zone. Wood sugar is not only a cattle food but a source for the production of yeast as well as of glucose for human consumption. Dr. Bergius suggests that for the over-populated industrialized European countries, wood may become an important factor towards independence of a food supply from abroad in the same way that the coal hydrogenation process will ensure independence of a foreign oil supply.

* * * * *

Remarkable results are claimed for a new leprosy treatment known as trypan blue, an aniline dye product. Treatment consists of six injectures of the dye, and a few minutes after the injection the body turns entirely blue. This disappears about six weeks after the injection, and the leprosy is then said to be completely cured. It is also hoped that trypan blue may form a cure for tuberculosis.

* * * * *

The activities of the Department of Scientific and Industrial Research are extensive and peculiar. A method of making dew operate a telephone is its latest invention, described in a report on " the measurement of humidity in factories and other closed spaces." It is known as the dew-point apparatus and it is designed to discover the temperature to which a metal must be cooled before dew will deposit upon it. Light is reflected from the cooled surface, and a photo-electric cell is so placed that some of the light scattered from this surface when dew begins to form on it falls on the cell and reduces its resistance. An electric circuit connected to the cell is so arranged that clicks are produced on a telephone in the circuit when there is no dew, but cease when dew is formed.

* * * * *

We offer our hearty congratulations to Sir Richard Gregory, editor of *Nature*, on his admittance as a Fellow of the Royal Society. It is not only a tribute to his many personal activities, but to the journal which he has conducted with such distinction for so many years. Sir Richard became assistant editor of *Nature* in 1893 and was appointed editor in 1919. He has also held the post of Professor of Astronomy at Queen's College, London, and has served as president of many scientific bodies. Sir Richard was knighted in 1919 and was created a baronet in 1931.

* * * * *

It is now possible to consider in proper perspective the value of the experience gained by the Mount Everest climbing expedition. The attempt was described in detail by Mr. Hugh Ruttledge, the leader, in two lectures to the Royal Geographical Society. Although Everest is an exceedingly difficult and dangerous peak especially in its upper reaches, Mr. Ruttledge considers that the peak can be climbed, given good weather conditions. He points out, however, that it is essential for the north face to be found with dry rocks and free from snow, and at least three days of consecutive fine weather are needed to give the climbers a fair chance. The monsoon this year was abnormally early, and the climbers only got short intervals of fine weather. Mr. Ruttledge does not think they had one completely fine day. With regard to acclimatization, experience shows that, once a man has been high on the mountain, however fit he might be, he will not be able to repeat his performance the same year, although he may be able to do so another year.

* * * * *

The interesting suggestion that wind is the cause of migration in birds has been made by Captain Bernard Acworth in a letter to *The Times*; he considers that the birds are borne away involuntarily. We have not heard this view expressed before and at first sight it appears to be a somewhat superficial explanation. While wind must be an important factor in migration, it seems improbable that it is the *cause*. As Mr. C. T. Carter, a keen observer of birds, points out, swifts are stronger flyers, for instance, than swallows or martins, and yet they migrate earlier. If Captain Acworth's theory is correct the swallow would be the stronger flyer, which does not appear to be the case.

Iraq Six Thousand Years Ago.

By M. E. L. Mallowan, F.S.A.

Field Director of Excavations.

The excavations at Arpachiyah, near Nineveh, were the first to be carried out under the auspices of the British School of Archaeology in Iraq, founded as a memorial to Gertrude Bell. Mesopotamia has now been revealed as a link in a cultural chain which extends beyond Crete to the west and to Persia in the east.

ARPACHIYAH is a prehistoric site in northern Iraq, in the upper Tigris region, no more than four miles east of Nineveh, with which it must have been closely connected in antiquity. It was in fact, as a direct result of excavations at Nineveh, that it was decided to excavate this small neighbouring site.

In 1932 an expedition to Nineveh, under the charge of Dr. Campbell Thompson, sunk a shaft in the great mound of Kuyunjik, and beneath seventy feet of débris discovered fragments of a finely made painted pottery, which was evidently the handiwork of the earliest peoples to enter Assyria. Arpachiyah revealed similar fragments on the surface, and appeared to be a compact site with no signs of débris later than the prehistoric period. The central ridge rose no more than thirty feet above the level of the surrounding barley fields, and being unobtrusive it had failed to attract the attention either of plunderers, or of previous archaeologists, and proved to have been very little disturbed since the days of its desertion.

Arpachiyah therefore offered a number of practical reasons for its excavation amounting to this: that the remains of the earliest known inhabitants of Assyria could be brought to light at a minimum of expense, in a short space of time. Further, we approached the site with certain specific problems to solve: first, to discover through what stages of evolution the early painted wares passed, and secondly in what order the three principal varieties of Mesopotamian painted ware succeeded one another in time.

The earliest known varieties of Mesopotamian painted ware fall into three groups. The southernmost group is that known as Ur Al Ubaid ware, which is found in the earliest levels of all the great south Mesopotamian cities, and occurs as far south as Bundar Bushir on the Persian Gulf, while in the north it occurs at Nippur, and at Kish it has been found not at all. The second group, known as Samarra ware, centres round Samarra, and its area of thickest distribution would seem to be a region corresponding very roughly with central Mesopotamia, as it is found profusely on the mounds of Kirkuk, and northward to Nineveh and beyond. The third group, known as Tall Halaf ware, has northern Mesopotamia and Syria as its general provenance.

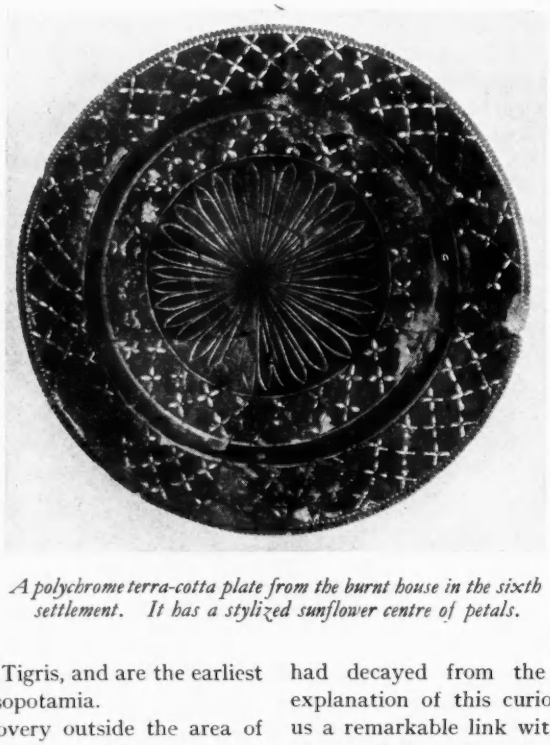
The importance of the excavations at Arpachiyah is that we have discovered for the first time all three wares lying in an orderly sequence on a single site. The top levelscontained complete vessels of the south Mesopotamian Ur Al Ubaid type, the middle levels contained fragments of Samarra ware, and the earliest levels complete vessels of Tall Halaf ware. From this evidence we

Excavators on the central ridge of Arpachiyah, where ten settlements were found.

are bound to draw the important inference that the civilization of northern Mesopotamia is older than that of the south, and that the Ur Al Ubaid ware was introduced to south Mesopotamia at a time when painted pottery was already at home in the north.

Preliminary excavations taught us that the habitations on the outskirts of the mound were both primitive and poorly preserved. House walls were of pisé or pudding-shaped lumps of clay, usually no more than four inches thick, and in the lowest levels there were traces of huts made of reeds and wattle. A small black soapstone amulet from the early levels seemed to represent a house with a gabled roof, resembling the typical village house existing in the neighbourhood to-day.

In the early strata we found that when houses had to be reconstructed it was a common practice to pack the abandoned habitations with stiff clay, to form a platform for the new level. During rainy seasons the ground therefore became very sticky underfoot, and this necessitated the construction of stone roads. These roads, which we found all over the site, consisted of large boulders and pebbles drawn from the banks of the Tigris, and are the earliest stone roads yet found in Mesopotamia.



A polychrome terra-cotta plate from the burnt house in the sixth settlement. It has a stylized sunflower centre of petals.

The most important discovery outside the area of the central ridge was a cemetery, which had been used during the last period of occupation. The bodies, the majority of which were inhumations, had generally been buried in the flexed position, on their sides, with the knees drawn up, as in sleep. With them were votive offerings, mostly painted pottery. Sometimes there were as many as six or seven painted vessels in a single grave, occasionally there were necklaces of glazed steatite beads, and there were knives of flint and obsidian. The designs on the pottery were done in a black or greenish black paint on a buff clay, and consisted of simple geometric motifs, such as running lozenges, hatching, and cross hatching. The vessels were badly fired, and the clay ill knit. Many of the shapes were distinctively southern in type, and the ware was closely related to that of Ur Al Ubaid. This cemetery provided one of many conclusive proofs that Arpachiyah was during its latest period occupied by a people with south Mesopotamian affinities, related to the earliest inhabitants of Ur and the great southern cities.

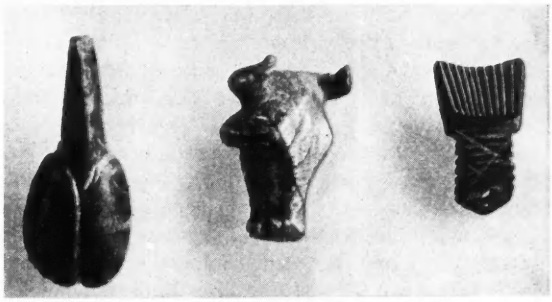
The cemetery of the Ur Al Ubaid period was also of importance because in addition to the ordinary flexed burial, it contained a number of *fractional* burials in which the skeleton was only partially complete. Often, the backbones, arms, or legs were missing; sometimes the heads alone remained. This type of fractional burial has been found at Mohenjo Daro in India, and at Nal in Baluchistan. Sir John Marshall has suggested that these skeletons may have belonged to persons whose bodies had been exposed to birds and beasts of prey, and they were only buried after the flesh had been picked from the bones. This would, of course, account for the absence of many of the bones. We must also remember the possibility, however, that they were re-interments made long after the flesh had decayed from the body. But whatever the explanation of this curious practice, we have before us a remarkable link with the burial customs of prehistoric India. That the similarity of practice is no mere coincidence, but corresponds with a racial kinship, is made more probable when we remember that the painted pottery associated with the Indian burials was observed to have distinctly Western affinities, and was intrusive on the Indian wares. Fractional burials have also been observed by De Morgan at Tepe Musyan in Persia. The available evidence points to a practice originating perhaps in some Iranian centre, and radiating eastward to India and westward to northern Mesopotamia.

After the excavation of the cemetery, the next task was to expose the remains lying in the central ridge. This ridge which rose to a height of thirty feet above

the surrounding fields had a diameter of about eighty feet at its base, and we were able to excavate more than two-thirds of it before the close of the season. The mound proved to have been the accumulation of a large number of settlements which had fallen into disuse and had been reconstructed one over another, after the manner of primitive habitations. We were able to examine the remains of no less than ten settlements. The top four and the latest of the series belonged to the Ur Al Ubaid period, so well illustrated for us by the remains in the cemetery described above. In these levels there were mud dwellings with flimsy walls and small rectangular rooms: houses were huddled one against the other and were little better than slums: there is little doubt that they belonged to a poor agricultural community who exploited the corn lands of the neighbourhood. And here it is interesting to note that nowhere did we find traces of fortifications, and that the absence of military weapons is a further indication that Arpachiyah was a peaceful agricultural centre.

The fifth settlement from the top belonged to a transitional period. Here we found the painted pottery of Ur Al Ubaid lying side by side with the more distinguished fabrics of the Tall Halaf Samarra period. It was evident that for a time the southern invader had lived side by side with the older northern occupants; but the two stocks had not lived for long in harmony, for in the top four settlements traces of the northern stocks ceased. Another indication that the fifth settlement belonged to an intermediate period was that the type of house became altogether more spacious in ground plan, and showed the more solid construction of the older settlements.

A well preserved vessel of the latest (Ur Al Ubaid) period, with black paint on a buff clay.



Some pendants typical of the early period, an ox's head in marble, a hoof in brown stone and a gabled house.

The sixth settlement was entirely northern in character; it was certainly the richest and perhaps the most interesting on the site. Here a remarkable collection of objects was preserved to us amid the débris of a destruction presumably carried out by the south Mesopotamian invader, whose remains formed the bulk of the succeeding settlements. One of the largest houses, lying in the centre of the mound had been destroyed by fire, and the roof which had been composed of mud and reeds had crashed on to the floor and buried the entire contents of the house beneath it. Fortunately, the house proved to have been a potter's shop, well stocked with painted wares belonging to the best period of Northern development. In all, more than one hundred and fifty objects were extracted from two rooms. And in addition to the painted pottery there was a large number of other objects which seem to have belonged to a worker in stone. Together with a large collection of flint and obsidian knives, there were the numerous chips that one would expect to find in the workshop of a lapidary.

Among the votive figures in stone, the most interesting was one of the mother goddess in limestone, and there was the figure of a man, no more than three quarters of an inch in length, carved out of alabaster, illustrating the skill of the ancient miniature stone worker. There were also several stone figures shaped like chessmen, mostly in white marble, and presumably votive. In obsidian there was a vase bored with a cylindrical drill, the earliest specimen yet found. Among the beads there was a necklace of obsidian and cowrie shells: the shells had probably had an infilling of red paint to contrast with the shiny black of the obsidian. Interesting were a number of rectangular links in obsidian, perforated at the ends and cut to many shapes and sizes. They seem to have been sewn on to some material, and have a remarkable analogy with some ivory links found at Mycenae, and there used as a protection for a leather helmet.

*

In the burnt house there were also many pendants, mostly in soapstone, drop shaped, with linear markings incised upon them. These pendants were used as seals, for in the same house we found many sausage-shaped clay labels, perforated lengthwise to take string and stamped with the same signs that were engraved on the pendants. Most important were a number of black soapstone amulets carved in the shape of a double axe. The double axe is well known as one of the most important cult symbols in ancient Crete, where it appears for the first time at the beginning of the third millenium B.C. in the Early Minoan period. In the sixth settlement at Arpachiyah we find it long before it made its entry to Crete, thus confirming Sir Arthur Evans' surmise, made many years ago, that the double axe reached Crete and the Mediterranean from somewhere in western Asia.

But the most remarkable find in the burnt house was the stock of painted pottery. In the same room we found the painter's palette, his stone mixing bowls, and a large lump of red paint identical with that used on the vessels themselves. Among the painted vessels the most beautiful were a number of polychrome dishes varying from twelve to fifteen inches in diameter: the centre piece was usually a stylized sunflower, the petals done in red on a black background, and the surround consisting of a red and black chequer pattern with quatrefoil rosettes painted on in white, after the vessel had been fired. Many different colours were used, including black, red, white, apricot and cream, and as the vessels had been lying in the soil for more than six thousand years, the freshness of the paint was remarkable. In general the pottery at this level represented the fullest development of the Tall Halaf ware; the fine quality both of clay and slip, skilful firing, lustrous paint, polychromy and richness and variety of design, distinguished it from the pottery of all other periods.

A Shrine.

Beneath the burnt house in the seventh level, we discovered the most interesting architectural feature on the site. This was a circular shrine eighteen feet in diameter, on rough limestone foundations, approached by a gallery on the major axis, twenty-six feet in length. The walls of the shrine were three feet thick, and from the ground plan we can have little hesitation in inferring a domical construction. That this building was a shrine, we may infer first from its prominent position in the very centre of the mound, and secondly from the fact that some of the richest burials on the site were dug against its walls. It was evidently desirable to be buried within the precincts of the building. Two vessels both associated with these burials deserve mention: one was a small egg-shell ware dish with a Maltese cross centre done in shiny black paint on a cream ground, and the other, a vessel shaped like a Persian or Arab begging bowl, with a design in flaming red paint on an apricot slip. These were two of the finest examples of painted pottery found on the site.

"Bee-hive" Tombs.

Beneath the circular shrine there were no less than four more buildings of a similar type: the earliest belonged to the tenth settlement below the top of the mound, the deepest level at which excavations were made. The importance of these buildings, the first of the type to be excavated in Mesopotamia, is their analogy with the bee-hive tombs of early Crete. But it is important to remember that there is a fundamental distinction, for whereas the Cretan examples were all underground, those at Arpachiyah certainly stood above ground.

The evidence from Arpachiyah shows us the sequence of the earliest known painted potteries of Mesopotamia: it shows us the pottery of Tall Halaf, Samarra and Al Ubaid following one another in an orderly series. We see also a tendency for naturalistic designs to evolve into stylized abstractions, particularly in the representation of the bull's head. Thus in the lowest levels the bull's head is represented in a naturalistic manner, whereas later on it is done with a single stroke of the brush, and in the end only the horns are represented. So, too, the leopard appears commonly on the earliest pottery, but later the beast is no longer drawn, and its spots only are retained.

Above all the material from Arpachiyah is proof of the essential homogeneity of prehistoric culture, so that Mesopotamia reveals itself as a link in a cultural chain which extends through the Mediterranean and beyond Crete on the west, and through Persia and Baluchistan to India in the east.

The expedition to Arpachiyah was under the auspices of the British Museum, and of the British School of Archaeology in Iraq, and had munificent support from the Percy Sladen Memorial fund of the Linnaean Society, Sir Charles Marston, and many other subscribers. These excavations were the first to be conducted under the auspices of the British School of Archaeology in Iraq, which was founded by the bequest of Gertrude Bell, who in her lifetime, had done much to foster Archæology in Iraq. Mr. J. Cruikshank Rose, A.R.I.B.A., was architect to the expedition.

The Transatlantic Air Route.

By J. L. Nayler.

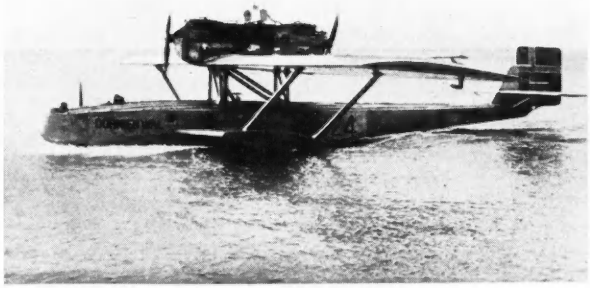
Secretary of the Aeronautical Research Committee.

In view of the Anglo-American agreement which has now been reached for a transatlantic air service, it is appropriate to consider the problems involved. The author states that we are within two or three years of a regular air mail route from Ireland to Newfoundland, to be followed by a passenger and goods service by way of the Arctic.

THE institution of regular air services across the Atlantic for mail and passengers has been the aim of many ever since the three crossings were made in 1919. We quote them here as they are in several ways typical of the problems before the companies who are considering the questions involved at the present time. The American Navy used three flying boats, N.C.1, N.C.3 and N.C.4, to fly from Trepassey Bay, Newfoundland, to the Azores on May 16th, 1919 : this flight was made up of a series of hops with stoppages for refuelling and repairs.

The first direct flight between America and Europe was that of the late Sir John Alcock and Sir A. Whitten Brown, who flew in a Vickers' Vimy twin-engine biplane from Newfoundland to North-West Ireland in 16 hours 12 minutes on June 14th, 1919. The third crossing that year was made a few weeks later by H.M. Airship R.34 with 34 persons on board. She left East Fortune on July 2nd and after encountering much bad weather on the latter part of the flight reached New York in 108 hours ; the almost immediate return to Pulham, Norfolk, took 75 hours : this crossing and return were made without much preparation.

The craft available to-day are of the same type, the seaplane, the aeroplane and the airship, though their sizes and speeds are all greatly increased. The main change is the consideration of a more northerly route via Greenland, the survey of which was first undertaken by the British Arctic Air Route Expedition during 1930 and 1931. But before we look at the possibilities of the routes it is as well to realize the importance that has been attached by various nations to securing the commercial flying rights along them.



E.N.A.

One of the Dornier Wal flying boats which the Germans are using experimentally for transatlantic flights.

The ocean routes are complicated by arrangements that have already been made : France has obtained exclusive rights in the Azores ; the United States has secured an exclusive licence for operation in Greenland ; Imperial Airways, the British company, has made an agreement with Pan-American Airways and the Aéro-Postale Company for joint operation of the Azores-Bermuda route ; Newfoundland is committed for fifteen years to Imperial Airways who have exclusive rights for air base purposes but have yet to decide on the nature of the control which shall be exercised over their air communications. Regarding this last it is understood that the British Air Ministry, the Canadian Government, Imperial Airways and Pan-American Airways have been in conference in view of the probability that Newfoundland will prove the key to the northern air routes across the Atlantic.

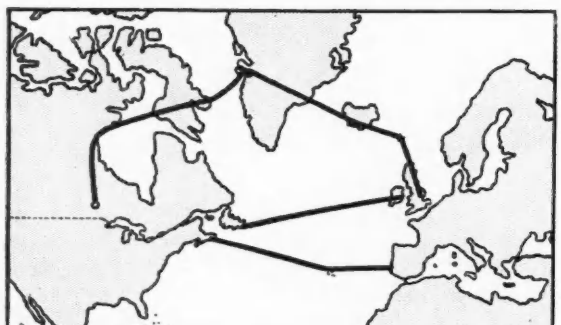
When we turn to the question of the journeys actually accomplished, we are met first with the striking fact that the Graf zeppelin maintains the only regular service, and that is across the South Atlantic. The captain and crew of this ship have crossed to schedule some eight or nine times for several years and recently celebrated the fiftieth crossing of the Atlantic by this ship : truly a notable achievement. The question arises immediately in one's mind as to why airships are not used for a regular service ; the answer is perhaps two-fold. Airships, particularly the larger ones, have in more than one country had bad accidents with considerable loss of life, which has tended strongly to persuade the public that this type of transport is unsafe : the answer is the Graf zeppelin's record.

The other reason is that the fares for flights

in this ship are too great at present for all but the few, and the ground organization needed for the maintenance of a service has not been fully developed except in Germany and to a lesser extent in South America. There is little doubt that an airship's overhead charges are considerable and the loss of a single flying unit may seem disproportionate to the passenger fares paid for a single trip. We must therefore leave for the present the reputation of the airship with the single operating aircraft, the Graf zeppelin.

Turning to the South Atlantic where the climate is more suitable for flying than in the north we find that several steps have been taken towards maintaining a regular service. The Germans have started experimentally with the aid of a refuelling station in mid-Atlantic. Two flying boats are to operate between Cadiz and Pernambuco. They will fly by way of the Canary Islands to Bathurst and will then be guided by directional wireless to the mother ship *Westfalen* midway between the two continents. The crossing will involve two flights of 900 miles each, which will allow the Dornier Wal flying boats to carry a reasonable pay load of mails, freight or passengers of about 3,000 lb.

To make the call for refuelling the *Westfalen* is equipped with an apron which can be let out over the stern and trailed slightly below the surface of the water. The seaplanes will thus have a fairly smooth area of water on which they can alight if the sea is rough. The first crossing in this way has already been made, and there is a good chance that this scheme or some modification of it will be a success. Nothing of a



(Above) Arctic route to Canada. (Centre) Direct route from Ireland to Newfoundland. (Below) Southern route.

similar nature has yet been proposed for the North Atlantic although the actual distances from the Irish Coast to Newfoundland is about the same. Instead the interested authorities have concentrated on the Arctic route.

This Arctic route need not involve a sea crossing of more than 300 miles as compared with the first direct flight across the Atlantic of 1,890 miles. The route contemplated from London to Winnipeg is roughly as follows: 700 miles to the coast of Sutherland or Caithness; 300 miles over the Orkneys to Thorshaven in the north of the Faroe Islands; 500 miles to Reykjavik in Iceland, of which 200 are overland; 300 miles over sea from Iceland to Greenland; 450 miles across Greenland to Disko Island; 400 miles, including 200 miles across the Davis Strait to Hudson Bay, 320 miles on to Fort Churchill; and then by existing air routes to Winnipeg.

In addition to the short stretches of sea and a longest stage along the route of only 660 miles, this route has the advantage that the fog belt associated in most readers' minds with Newfoundland does not extend beyond 65° N. latitude and could therefore be avoided. An ice cap with a height of 7,000 to 9,000 feet, however, separates the east from the west coast of Greenland and may prove a difficult obstacle to surmount.

These and other problems were studied by the British expedition to Greenland in the summers of 1930 and 1931 and the intervening winter, and have since been the subject of study by the German pilot Commander von Gronau in August, 1931, and Colonel Lindbergh during this autumn. The British used two D.H.60x Moths with exhaust-heated cock-pits and extra tankage to permit a range of 560 to 600 miles with these aircraft. The late Mr. H. G. Watkins described the experiences of the expedition in his paper read before the Royal Geographical Society; the section of most interest to us is the supplement written by the chief pilot of the expedition, Flight-Lieut. N. H. D'Aeth, R.A.F. He and his fellow pilot made some 74 flights under a great variety of conditions. They found that rapid changes of wind and tide moved the ice in the fjords and made them normally unsuitable. A survey of the country showed, however, that there were two lakes, one near Angmagssalik measuring $2\frac{3}{4}$ miles by 1 mile, and another 3 miles by $\frac{1}{2}$ mile, which would be eminently suitable for operation with seaplanes in the summer and with aeroplanes fitted with skis in the winter. When the ice was forming or thawing for periods of five or six weeks in both spring and summer, these landing grounds might not, however, be available. Flight-Lieut. D'Aeth also remarks that fog only occurs on the coast for about ten days in the year, when the ice is breaking up, so that the possibilities of the successful operation of an air

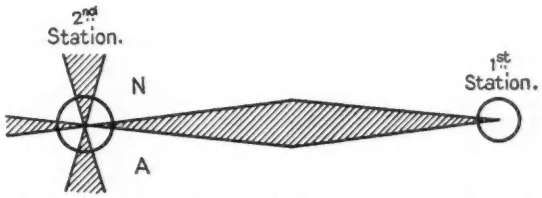
service are by no means remote. That experienced pilot, Colonel Lindbergh, has recently supported the view that these lakes are likely to be satisfactory and in his cautious manner is reported to have said at a London lunch party that the route is satisfactory.

There remain, however, the vagaries of the weather which are more pronounced in Greenland than further south. Very strong Föhn gales are apt to spring up suddenly without any warning from the barometer, but it may be that these are avoidable as Colonel Lindbergh suggested. During these gales also the new ice is broken up and large wind drifts are formed on the surface of the ice cap, making landing under such conditions an impossibility. Moreover, the winds vary in direction and strength at different heights which complicate appreciably the navigation of the aircraft. All these difficulties could, however, be got over if there was a good ground organization and aircraft sufficiently fast to fly against the head winds or to operate at such heights with multi-engines that forced landings need not be contemplated. The mere distance of operation and the incidence of considerable cold are neither matters which need stand in any way against the operation of present-day aeroplanes or seaplanes.

There remains perhaps the difficulty of navigation but with the experience gained in wireless methods in the operation of the air mails in U.S.A., there need be no difficulty in finding the air port as there may be with the ordinary compass, owing to the fact that the magnetic pole is located south of Greenland. Aeroplanes can tell by their instruments if they are in the wireless beam shown in the diagram or on either side of it. Given a good meteorological service there does not then seem to be any reason why the so-called Arctic route should not be operated by aeroplanes and seaplanes.

We have left to the last the most attractive and the most difficult of the Atlantic air routes, namely, that direct from Ireland to Newfoundland, a distance that is only a third of the greatest distance covered in a single flight without refuelling and only a small fraction of that which has been covered by an aeroplane flying continuously in a closed circuit with the aid of refuelling in the air. The speed of the aeroplane is an important factor in this route if a service both ways is to be contemplated. Let us suppose that the distance between the two chosen air ports is 2,000 miles. If an aeroplane on the route cruises at 100 miles an hour it would take 20 hours with no wind. The average wind is, however, over 20 miles per hour from west to east, so that the eastern crossing by this aeroplane would take less than 17 hours and the western 25 hours because the aeroplane's speeds over the seas would be respectively 120 and 80 miles per hour.

Now the United Air Lines have more than 60 Boeing



Wireless signal system for directing transatlantic aircraft.

aeroplanes, type 247, operating in U.S.A. at a cruising speed of 170 m.p.h. This aeroplane would cross the one way in about 10½ hours and the other in about 13 hours, which time seems to provide a feasible proposition. With its present pay load of 10 passengers and 400 lb. of mail and freight it has, however, only a range of 800 miles. There is no reason why the pay load should not be decreased to give an increased range but it could not carry a paying load for 2,000 miles.

Faster aeroplanes than the Boeing are being designed including some in this country as well as America, but the fastest air liner at present is the United States V.I. transport which has a cruising speed of 195 m.p.h. and a top speed of 220 miles per hour with eight passengers. This great speed is attained by completely retracting the undercarriage with its wheels. With such a top speed the western flight could be completed in ten hours but the time for this has not yet come.

The most popular idea both in this country and in America is to use refuelling in the air, which could be undertaken by aircraft operating from ships on the route. Pan-American Airways is, however, providing itself with flying boats which could make the journey without refuelling. These boats have a range of 2,500 miles against a head wind of 30 miles an hour and should, therefore, be adequate for an average crossing from Ireland to Newfoundland and more than adequate for the eastern flight.

The difficulties of air operation between Europe and America must not be underestimated, and as a start there will need to be a large capital expenditure for ground organization and meteorological services whichever route is adopted. We do, however, appear to be within two or three years only of a regular air mail service between Europe and U.S.A. to be followed by a passenger and goods service. The aim for the former will be the direct Ireland-Newfoundland route and the latter may be by the safer Arctic route with its shorter hops.

Science and Religion—II.

Moral Aspects of the Search for Truth.

By the Rt. Rev. H. Hensley Henson, D.D.

Bishop of Durham.

The first part of the Bishop of Durham's article, based on his Fison lecture, was published last month, when the author discussed the moral obligations of the scientist. In the second part which follows he expresses the view that "science divorced from ethics carries the potency of a measureless calamity for mankind."

THE infliction of pain in laboratory experiments appears to me irrelevant to the moral issue, which properly turns on two points, viz., whether the reasons for which the pain is inflicted—much or little makes no essential difference—are adequate, and whether such infliction does, or does not, violate the sufferer's inherent and indefeasible rights.

Moral Limitations.

Mere curiosity would be no adequate motive for inflicting pain. The formula, "Knowledge for its own sake," must be applied with discrimination. It raises the question—What kind of knowledge is to be pursued? Is every kind of knowledge desirable in itself, and rightly to be pursued by moral agents? In the pre-scientific age there were certain areas of knowledge which were held to be prohibited to Christians, because they could only be entered on intrinsically sinful conditions—having recourse to demons or sorcerers or otherwise trafficking with Satan. In our scientific age, when Satan and his sorceries have receded beyond the region of scientific belief, is there any analogous limitation imposed on inquiry by morality itself? "There is a Nemesis which waits upon those who deliberately avoid avenues of knowledge," say Professor Whitehead; but are all avenues of knowledge open to self-respecting students? Is there not also a Nemesis on those who, in their eager pursuit of knowledge as such, allow themselves to ignore the restraints which Morality imposes on human action?

Inquiry by the method of experiment deliberately arranged by the student himself has added gravity to these questions. Professor Whitehead distinguishes between the cause of Science and that of "free imaginative speculation." May not experiment be inspired by the last, rather than by the first? Vivisection in order to satisfy curiosity apart from a genuinely scientific purpose could not possibly be justified by any tolerable casuistry, and the Law, in conditioning the use of this scientific method by severe restrictions designed to rescue it from the service of mere curiosity and to keep it strictly within the ambit of scientific purpose, is entirely reasonable.

But, given the adequacy of the motive, is there nothing more to be said? Has the animal no right to be heard? I think the case for vivisection turns finally on the view taken of animals. And here it might well appear that modern Science has itself armed the opponents of vivisection with a formidable weapon. For may it not be plausibly argued that Darwinian biology has taken away the ring fence by which the scholastic philosophy has segrated man from the other animals, and invested him with the unique attribute of personality? Must we not acknowledge that, when we describe animals as man's poor relations, we are using language which is not merely picturesque, but also essentially true? At least we must admit that the dividing line between the human and the non-human is not altogether easy to draw. Organic life has for us the aspect of a single phenomenon, though infinitely graded and various. Nevertheless, there is a distinction which cannot be ignored. Personality cannot, without misuse of language, be attributed to any animal but *homo sapiens*. Therefore, where man is in question the interest of Science must give place to a still higher consideration. If, indeed, the interest of Science were of itself sufficient to determine the matter, the vivisection of human beings could not be resisted, for it is certain that the fundamental difference between the bodies of men and the bodies of animals largely reduces the practical value of experiments on the latter.

Violating Personality.

It is the violation inflicted on personality that finally prohibits the vivisection of men. Here we must draw the line between the human and the non-human. Even the higher apes and those domestic animals which have companied longest and closest with man can at most be credited with the rudiments of a moral sense, the undeveloped potencies of personality. May we, then, argue boldly that, since rights attach to persons, and since animals are not persons, animals can have no rights? May we ground our requirement that animals shall be treated humanely, not on their

rights, but on man's duty to himself? I think that we may not deny that the moral conditioning of the scientific method is here indirect, through the human student's self-respect; not direct, through the animal's inherent rights.

I observe that in his recently published "Apologia" Dr. Orchard seeks to reconcile the stern scholastic view that animals have no rights with his own sensitive humaneness thus :—

"This doctrine," he writes, "is not as harsh as it sounds: rights can properly belong to God or to man; nevertheless God retains rights over the animal creation that man must not overstep; and man certainly has duties to animals." (*V.* "From Faith to Faith," p. 285.)

Sacrificing Animals.

This reasoning, perhaps, might suffice if vivisection for scientific purposes stood alone, but in fact it does not. Suffering is inflicted on animals for many other reasons than the interests of Science. We require a theory which shall cover the entire relations of man with his non-human contemporaries. The castration of domestic animals, the severities of their breaking-in to human service, the hard conditions of that service, their suffering and death in the interest of man's amusement, and so forth, not less, perhaps even more plainly than vivisection, challenge the casuist's skill. In his recently published "Autobiography" Dr. Albert Schweitzer explains the philosophy by which he was able to reconcile himself to the sacrifice of animal life :—

"To the man who is truly ethical," he writes, "all life is sacred, including that which, from the human point of view, seems lower in the scale. He makes distinctions only as each case comes before him, and under the pressure of necessity, as, for example, when it falls to him to decide which of two lives he must sacrifice in order to preserve the other. But all through this series of decisions he is conscious of acting on subjective grounds and arbitrarily, and knows that he bears the responsibility for the life which is sacrificed." (*V.* "Autobiography," p. 271.)

We may think, perhaps, that in these words the great scholar, scientist and servant of mankind rather confesses the insolubility of the practical problem than offers a solution.

Ought we to conclude that in no case may men be subjected to vivisection in the interest of Science? I have already alluded to those scientific students who of their own free choice have subjected themselves thereto, and are for that reason universally held in honour as the martyrs of Science. In their case the moral issue does not arise, but only in the case of those who have no option—the child, the slave, the imbecile, the criminal. Is there any moral objection to the vivisection of criminals who, by the laws of their country, have been condemned to death? In their case the issue of inherent human rights cannot be raised, for these have already been cancelled. To imprison, flog, and hang or electrocute a criminal must be allowed to imply a violation of his human rights not less gross than to subject him to vivisection. We say, very justly, that by his crimes he has forfeited his rights, and we deal with him penally on that hypothesis. Why should not his punishment take a form which is serviceable to the community? Why should he not at least be given the opportunity of making in this way some atonement for his sins against society? In the case of the criminal whose natural rights have been cancelled, much may be legitimate which in the case of innocent persons like the slave and the child would be altogether inadmissible. How far could a doctor be justified in sacrificing life in order to effect a cure? Here is an illustration from the 15th century :—

"It is said," writes Bishop Creighton, "that a Jew doctor offered to cure the Pope (Innocent VIII) by transfusion of blood. Three boys of ten years old were chosen for this purpose, and were paid a ducat each; they died in the experiment, and the Pope obtained no benefit." (*V.* "History of the Papacy," iii, 153.)

Even if the experiment had been successful, would it have been morally legitimate? Transfusion of blood is now, I am informed, a familiar and not particularly dangerous medical method, but in the 15th century it was both novel and fatal. Was the Jew doctor morally entitled to use it? Ought he not to have been tried for wilful murder?

Ethical Considerations.

The goodness and importance of the object aimed at cannot, I submit, suffice to authorize the use of experiments which involve violations of morality. Among the many legends which have gathered about the fascinating personality of the mediæval emperor Frederick II there is one which illustrates both his fondness for scientific experiment and his indifference to the ethical considerations by which such experiment ought to be conditioned. Dr. Coulton, in his interesting volume, "From St. Francis to Dante," quotes the the following from the contemporary chronicler Salimbene :—

"He (*sc.* the Emperor) fed two men most excellently at dinner, one of whom he sent forthwith to sleep and

the other to hunt; and that same evening he caused them to be disembowelled in his presence, wishing to know which had digested the better; and it was judged by the physicians in favour of him who had slept." (*V.* "From St. Francis to Dante." p. 243.)

Frederick's curiosity was legitimate, and his desire to satisfy it by the scientific method of experiment was entirely praiseworthy, but the actual experiment was insufficiently conditioned by ethical considerations.

A few years ago considerable public attention was directed to the experiments of Dr. Serge Voronoff. These are plainly described in his published volume, "Rejuvenation by Grafting," so plainly that even the non-technical reader can easily understand their nature, object, and the measure of success which is claimed for them. Voronoff's experiments are extremely repulsive, but they are so plainly germane to our present discussion that I cannot omit a reference to them. I need not describe them because I may fairly assume that most of my readers are sufficiently familiar with them. I ask whether "rejuvenation by grafting" is a legitimate scientific method. It seems to me to involve a cynical contempt for human nature, and to open the door to further experiments which are utterly repugnant to morality. But is the method, from the scientific point of view, legitimate? And, if it must be answered that it is not, then the question presses for answer—Why not? What concern has Science with Morality? Does not the acquisition of knowledge justify any and every experiment?

If the adoption of morally objectionable methods is prohibited even when these are adopted for ends which are unquestionably good, what shall be said for the use of morally legitimate methods in pursuit of knowledge which would certainly or probably be practically mischievous? How far are the students of Science morally entitled to ignore the quality of the results which would surely follow from their discoveries?

Determining Sex.

Recently I was interested by reading in *The Eugenics Review* some editorial comments on the alleged discovery of a scientific method for determining the sex of children. After expressing some scepticism as to the fact, the editor proceeded:—

"We must be prepared, nevertheless, for the announcement any day of reliable methods of forecasting or even controlling sex. . . . This highly probable eventuality would prove, without exaggeration, the greatest revolution in the history of mankind, and we can only speculate whether the proportion of boys to girls will be ten or twenty to one. What the effect will be on our social and sexual life is beyond the most unflinching imagination. Certainly the ideals of monogamy and female chastity will be among the very first to be threatened.

"Is there any chance of a modern government looking a few years ahead and providing even a memorandum in preparation for the upheaval? A more hopeful, if still slender, prospect is that the biologists of the world may agree in advance—*now*—to keep this knowledge, more dangerous than any new explosive, to themselves, instead of broadcasting it, like Dr. Sanders, to the popular press. It would leak out eventually, of course, but there might, perhaps, be time to erect a few barriers against the monstrous regiment of men." (*V. The Eugenics Review*, October, 1932, p.1.)

The Biologist's Duty.

Assuming, for the sake of argument, that the situation has actually arisen, that scientific men are on the road to acquiring this formidable knowledge, and that the consequences, if it were communicated to the public and generally acted upon, would be what the editor indicates as probable, what is the duty of the biologist? Ought he to abandon his hopeful researches and, in the interest of sexual morality, refuse the knowledge which they promise? Does it suffice that he should ignore the consequences of his discovery on the broad ground that, as a man of science, his concern is solely with knowledge as such, and that, therefore, his scientific activity is properly exempt from the principle which confessedly governs every other, viz., that a man is responsible for the certain or probable consequences of his acts.

The ethical conditions of scientific method have been forced on our attention by our recent experience of war scientifically waged. Take the case of poison gas, the use of which is, perhaps, the most hideous and horrifying feature of modern warfare. Is it enough for the chemist to plead that his concern is solely with adding to the sum of human knowledge? May he rightly contend that he is not concerned with the effect of his discoveries on the happiness or misery of mankind; that to the votary of Science moral considerations are irrelevant, since, in Professor Sorley's words, "Science is ethically and æsthetically impartial"?

If Locusta was rightly held to be infamous when she concocted poisons to destroy individuals who had fallen under the ban of an emperor's hatred, can the modern chemist be held guiltless when he sets himself to discover poison-gases to destroy armies and cities in the interest of national policy? Even if we may

assume that the sordid motive of personal gain which inspired the one will have no influence on the other, does the difference suffice to authenticate a procedure which is intrinsically immoral? Must it not rather be insisted upon that the obligations of manhood take precedence of the franchise of science; that no man can divest himself of his humanity when he enters his laboratory, and that, in short, Science forfeits its principal claim to human regard when it ceases to be beneficient. Westermarck's observations on curiosity are, perhaps, relevant to this point :—

Love of Knowledge.

"When highly developed, it (*sc.* curiosity or love of knowledge) drives men to scientific investigations even though no practical benefits are expected from the results. This devotion to truth for its own sake, pure and disinterested as it is, has a singular tendency to excite regard and admiration in everyone who has come under its influence. From the utilitarian point of view it has been defended on the ground that, on the whole, every truth is in the long run useful and every error harmful, and that we can never exactly tell in advance what benefits may accrue even from a knowledge which is apparently fruitless. But it seems that our love of truth is somewhat apt to mislead our moral judgment. When duly reflecting on the matter we cannot help making a moral distinction between him who pursues his studies merely from an instinctive craving for knowledge and him who devotes his life to the search of truth from a convinction that he may thereby promote human welfare." (*V.* "Origin and Development of Moral Ideas," ii, 135.)

Recent developments of Science have so apparent and powerful an influence on man and society as to compel reflection even in the most resolutely optimistic minds. It has been too confidently assumed that the increase of knowledge will benefit humanity, that the control of Nature will serve the interest of society. A new note of anxiety is audible in the utterance of the masters of Science. Even the layman is perturbed when he hears successive Presidents of the British Association—General Smuts and Sir Alfred Ewing—emphasizing the perils into which the rapid progress of Science is bringing civilized society. Like a mediæval magician the man of Science seems to be raising demons which he has no power to control. Sir Alfred Ewing spoke of applied mechanics in a tone of sadness and apprehension :—

"An old exponent of applied mechanics may be forgiven if he expresses something of the disillusion with which, now standing aside, he watches the sweeping pageant of discovery and invention in which he used to take unbounded delight. It is impossible not to ask, Whither does this tremendous process lead? What, after all, is its goal? What its probable influence upon the future of the human race? . . . Beyond question many of these gifts are benefits to man, making life fuller, wider, healthier, richer in comforts and interests and in such happiness as material things can promote. But we are acutely aware that the engineer's gifts have been and may be grievously abused. In some there is potential tragedy as well as present burden. Man was ethically unprepared for so great a bounty."

Mechanical Science, which Sir Alfred Ewing had primarily in view, affects the conditions under which civilized society exists, and thereby brings a heavy, even it may be an intolerable, strain on human character, but biology and its ancillary sciences aspire to explain, manipulate, and transform human nature itself. The citadel of personality is visibly endangered. The fountains of moral and intellectual freedom are dried up, and there is opening before humanity the promise of a bleak and stereotyped future from which all that has hitherto created the grace and glory of human achievement will have been withdrawn. Thoughtful observers of scientific progress find in what they see more that creates fear than nourishes hope for the destiny of mankind.

In a powerful but extremely repulsive novel Mr. Aldous Huxley has pictured the complete victory of Science, and bidden us realize what consequences would follow from the frank application of Science to human life apart altogether from ethical considerations. In the "Brave New World" which he describes with brutal realism, personality has been subtly annihilated, and with it religion, morality, romance, idealism have perished. No doubt the novelist's picture is grotesque in its extravagance, but the grotesqueness is that of a successful caricature, which must needs owe its success to the measure of its fidelity to fact. It distorts features which are real and recognizable, and which the very distortion emphasizes and interprets.

The Future of Humanity.

Science divorced from ethics carries the potency of measureless calamity for mankind. My purpose is not merely to give expression to that melancholy foreboding, but also to raise the question how, and where, and when the indispensable conditioning of scientific method by morality ought to be effected. On the right answering of that question I apprehend that there depends no less an interest than that of humanity itself.

The Survey of Glaciers.

By A. E. H. Tutton, D.Sc., F.R.S.

Although the movements of glaciers have been studied for more than a hundred years, it is only recently that observations have been adequately organized on an international scale. Dr. Tutton describes the methods employed by surveyors, and shows how much their work has done to prevent the disasters which formerly involved great loss of life.

THE slow but sure changes which occur in the dimensions and volumes of glaciers have for more than a century formed the subject of close study. Research has been specially directed towards the termination of glaciers in their valleys of descent—the signs of their "advance" or "retreat"—and the relative movements of their parts. At first the work was carried out by men of science, often in their private capacity at their own charges, with the primitive means of observation then alone available, but of later years the study has been systematized by the combined efforts of official government departments and of the organized scientific forces of Glacier Commissions, both national and international. This mass attack has been highly effective in revealing much more of the wonderful nature of these grand and immense natural rivers of ice, some even in Europe extending to nearly a score of miles in length. Moreover, these regular surveys have been the means of reducing to very small dimensions, and even of absolutely preventing, the disasters which formerly brought to ruin so many lovely Alpine valleys and destroyed so many lives.

New Principles.

The character of any particular glacier is largely determined by its bed, the slope of the mountain on the side of which it is formed by the ever downward pressure of the upper snowfields and *nevé*, and by the nature of the valley down which it eventually finds its way. That is, it must be observed whether it is more or less crevassed or even torn into séracs, and in extreme cases precipitated as an icefall like that of the Rhone glacier. But there are many other factors contributing to its general appearance at any given moment. Such are, pre-eminently, the amount of snowfall which it receives, its *enneigement*, and its net loss in melting caused by solar heat, after accounting for the amount of refreezing during the night, and on cold wintry or stormy days. Hence, data as to the amount of snow accumulated and dissipated, and the net residue remaining as snow, *nevé*, or solid ice—the *nivometry* of the glacier—are all of essential value and necessarily included in a complete survey. Further, not only are obvious surface conditions, size and volume, amount and velocity of movement of the glacier, invariable items of observation, but serious and occasionally successful attempts to determine the depth (thickness) of the glacier at a given point have in these later days been made on certain of the more important glaciers, by the more refined instrumental methods now available, involving in some cases only recently discovered principles.

Many Observations.

The ordinary theodolitic, geodesic, and triangulatory methods of survey have, of course, been used, as well as the measuring of the positions of fixed marks, deeply driven-in stakes and other erections on the glacier relatively to fixed points on the rocks at the sides. These methods have been brought up to date with the more perfect surveying instruments of to-day. In addition the work has consisted in the following observations: Recording regular readings of immense nivometers, scales in metres and half-metres engraved on suitable rocks standing vertically up from the glacier; recording the "state of the snow" of the *nevé* from density determinations; estimating the total and residual *enneigement* of the net bulk of the ice; taking soundings of the depth of the ice, between the surface of the glacier and its bed, by various methods adapted from those invented during the war (hydrophones) for depth-sounding at sea (and best of all by the method of the earthquake seismometer—determining the length of path of a seismic wave between the surface and bed); and finally, perhaps most interesting of all, determining the minute daily movements of the extremity ("snout") of the glacier by means of an ingenious little instrument, the cryocinemeter, invented by Professor Paul Louis Mercanton, the Chairman of the Commission Suisse des Glaciers and Professor of Geophysics at Lausanne University. The writer spent a most interesting day last summer with Professor Mercanton, who has been for many years collecting the information for and compiling the reports of the Commission. Besides these essential observations, many others of a particular nature, on specific glaciers chosen for more detailed study, have been carried out, throwing an infinitely clearer light on the very remarkable phenomena of glaciology.

During the twenty years preceding the war,

1894-1914, the Commission Internationale des Glaciers supervised the work of glacier survey in Europe, and also published an annual report, the last, for 1913, appearing in 1914. After thirteen years of inactivity, the old lines of work being impossible, this Commission in 1927 dissolved itself, and became replaced by a new Commission des Glaciers, under the auspices of the Section d'Hydrologie of the Union Géophysique et Géodésique. Its first report was published in 1930, and summarized the variations in the lengths of the Alpine (Swiss, French and Italian) and Scandinavian glaciers, as far as the data accumulated in those years (1913-1928) was available. The Swiss observations have been made by the Cantonal Forestry officials, the French (Savoy and Dauphiny) observations by the officers of the Department des Eaux et Forêts of the Ministère de l'Agriculture and the Italian observations by departmental officers of the various districts. In the comprehensive report (1914-1928) data are given for each year for 26 Savoy and Dauphiny glaciers, 101 Swiss glaciers, and 77 Italian ones, besides a considerable number of Austrian, Norwegian, and Swedish glaciers. The change of length is given to a half-metre, a positive value indicating advance and a negative sign indicating retreat.

Professor Mercanton depositing shells on the Rhone glacier to measure its movements.

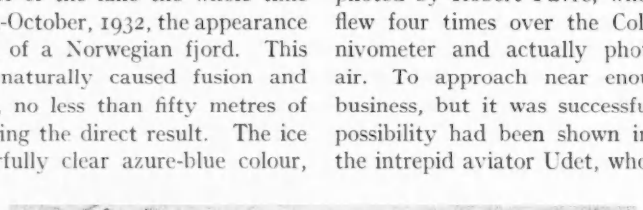
It need scarcely be pointed out that the terms "advance" and "retreat" refer to the increase or decrease in total length, as afforded by the position of the "snout" termination. For of course the ice is always bearing downwards, the position of the snout-end being determined by the net balance of fresh precipitation and loss, dissipation, by melting. When the former is the greater the glacier is advancing, encroaching on the terrain in front of its snout; when the latter is in excess, the glacier is in retreat.

It will be of interest to be reminded that on August 11th, 1840, Professor Louis Agassiz and some companions from Neuchâtel initiated the first really scientific attempt at the measurement of glacier movement. They constructed a durable bivouac-shelter out of a large clock of micaceous schist, which arose on the ridge of the great medial moraine of the Unteraar glacier, and arranged for its regular revisitation and determination of its position. In 1842, however, they quitted this precarious refuge, facetiously called the Hotel des Neuchâtelois, for a hut on the left bank, the well-known Pavillon Dollfus. In 1844 the block had already split in two, in consequence of violent storms and continual changes of level of the glacier in its slow but sure movement downwards. Long lost to view, it was re-found in at least three pieces by a tourist, and its position measured in 1884 by Professor F. A. Forel. In 1899 it was reviewed by him, and again by Messrs. Bonard and Riklin in 1904.

Lastly, it was discovered in eight pieces in 1922 by Professor Mercanton and a party of his students from Lausanne, and a life-history of its movements was constructed by them, the travel since 1842 being well established with the aid of the most recent form of theodolite. For, happily, in 1842 Wild had determined the position of the original block with great care; the number two was still clearly visible on it when Professor Mercanton found it, and on other of the eight pieces found were still legible the carved names of Agassiz, Nicolet, and Stengel, ensuring their trustworthy identification. The block had early quitted the crest of the moraine, and glided along its left flank down to the bordering ravine. Starting from a fixed point on the Abschwung, where the two great affluents, the Finsteraar and Lauteraar glaciers join to produce the Unteraar glacier, the positions at each of the epochs, 1842, 1884, 1899 and 1922 were found to be respectively 0.9, 3.2, 3.8, and 4.6 kilometres. These correspond to the following velocities: 1842-1846, 74.0 metres per annum; 1846-1884, 51.5; 1884-1899, 40.0; and 1899-1922, 32.2.

The diminution in velocity is partly due to the drive to the left from the middle of the glacier, and partly to the diminution of the glacier, the end of which was continually in retreat from 1872 to 1922. We have thus a continuous record for eighty years of the movement of this very interesting glacier. And the work of Professor Mercanton is only just in time. For owing to the completion in 1931 of the barrage work at the Grimsel (for the provision of immense electric power

stations at Handret, Boden and Innerkirchen), and the consequent very large increase in the size of the lake now three and a half miles long, the end of the Unteraar glacier has actually been reached by the waters. Cliffs of ice twenty or more metres high were standing up directly out of the lake the whole time from August 19th to mid-October, 1932, the appearance being exactly like that of a Norwegian fjord. This attack by water has naturally caused fusion and undermining of the ice, no less than fifty metres of retreat of the glacier being the direct result. The ice cliffs were of a wonderfully clear azure-blue colour, and formed a very beautiful spectacle during the summer months. The old Grimsel hospice, so well remembered for its resonant sleep-preventing wooden cubelet-rooms, has disappeared for ever, the lake covering its site, and a new hospice has been built on the rocks well above the new lake level. Besides the loss of 206,500 cubic metres of its snout due to the lake, the Unteraar glacier has lost in the last two years another 2,373,000 cubic metres of its volume. All this renders it the more fortunate that Professor Mercanton's completion of the work of Agassiz should have occurred before this large disturbance of the conditions.



Apparatus used on the Glacier de l'Eiger to measure its thickness. The instruments are similar to those used for depth-sounding of water.

Before proceeding to give the latest results of the official measurements, a few words about the new refined methods are due. And first as to *enneigement* and its determination by nivometry. On a lovely autumn day, September 22nd, 1902, three members of the Diablerets section of the Swiss Alpine Club, Messrs. Mercanton, Lacombe and Ramelet, painted the first nivometric scale in the Alps on the Glacier d'Orny, the realization of a suggestion of Forel in 1890. The readings were undertaken by the guardian of the Cabane Panossière, especial care being taken to get the spring, summer and autumn snowfalls, and to determine the net annual residue of *enneigement*. Several times in the intervening thirty years this nivometer has been laid absolutely bare, but generally there was a clear residue of snow recordable. A photograph of Professor Mercanton's nivometer is here reproduced by his kind permission. In 1931, as illustrating modern innovations, Professor Mercanton, piloted by Robert Favre, who was afterwards killed, flew four times over the Col d'Orny, and read the nivometer and actually photographed it from the air. To approach near enough was a very risky business, but it was successfully accomplished. The possibility had been shown in the previous year by the intrepid aviator Udet, who actually landed on the snow adjoining the nivometer. Many other nivometers and "balise" scales have been painted on rocks, or erected, on other glaciers, notably on the Col de Berthol, the Diablereta, and the Jungfraujoch.

The cryocinemeter of Professor Mercanton, for the determination of the minute daily movement of the actual snout-end of a glacier, as used by him this present year (1933), is a simple but most efficient little instrument. All of it packs into a box only seven by five by three inches in size, and thus easily goes into the rucksack or even a large pocket. It consists of a brass tube, just over an inch in diameter and closed at one end, and having a small hole bored through the cylinder wall near the other end, through which a fine silver wire can be inserted. The cylinder is to be sunk in a hole bored in the ice by a bracebit of the same diameter (the bit being supplied), and filled with a salt-and-ice freezing mixture. The wire is inserted through the little hole in the cylinder, and as soon as it has frozen hard and fast the wire is led horizontally to and wound several times over and round a little pulley, and then hangs down and becomes stretched taut by a weight adequate for the purpose attached to its end. The pulley is carried by an axle projecting from a small metal case carrying clockwork gear for magnifying very considerably the motion of the pulley, and a couple of indicator dials

on the other side of the box afford clear indications of the amount of movement (the magnification being taken into consideration); one indicates the units and the other registers the decimals of centimetres. The case of clockwork is to be very rigidly mounted by a clamp provided, on either an ordinary photographic tripod or even an ice-axe head, firmly planted or fixed in front of the snout-end of the glacier.

The surface and end movements are thus now accurately determinable and well known, but the movements in the depths of glaciers are still very obscure. In 1928 Professor Mercanton and his associates deposited nineteen 75 mm. shells in the Rhone glacier, each containing an identity piece sealed in by a screwed stopper, and having a sequence number deeply engraved on the outside of the shell. It is hoped that they will long resist attack in the interior of the ice, and also erosion by the rocky bed when they reach it, and that they may afford testimonies of the movements of the glacier for many years to come; their exact positions have been accurately determined by the theodolite on placing them, with reference to fixed marks on the adjacent rocks. Similar shell deposits have also been made in the Great Aletsch glacier, both under the Jungfraujoch on the Eggishorn side and on the Bernese side.

The nivometric scale painted on the Glacier D'Orny. All the photographs are by Professor Mercanton.

Precise determinations of the thickness of glaciers have been of much rarer occurrence; those of Agassiz on the Unteraar, of Mougin and Bernard on the Tete Rousse, of Hess and Blümcke on the Hintereisferner, and of Vallot on the Mer de Glace, are the outstanding ones. Attempts of later years to employ the new methods of depth-sounding in water (hydrophones, ultrasones, vibratory quartz-plate piezo-electric devices, etc.), have not met with the hoped for success. For glacier ice is not homogeneous like water, and wave-motion within it is subject to far greater degrees of absorption. Better results have been afforded by use of the geophones of Professor Jean Perrin of the Collège de France, such as were used by the sappers in the war to localize enemy saps. The Rhone and Corbassière glaciers were thus investigated by Professor Mercanton. On the latter glacier, near the Cabane Panossière, at 22 metres from the right bank of the glacier, the best of three explosions of cheddite gave the echo from the bed at 0.08 second, and assuming the correctness of the previously determined rate of propagation of the sound wave, 1.9 km/s., the result was 102 metres for the depth of the glacier bed. For the sake of confirmation the formula of Professor Somigliana was used in another calculation and gave 107 metres as the depth, a fairly good agreement.

On the Lower Grindelwald glacier, near Baregg, echoes corresponding to depths of 114 metres were obtained, which again agreed with the results of calculations made by use of the Somigliana formula. These thicknesses are, of course, much smaller than the large value of 200 metres found by M. Joseph Vallot on the Mer de Glace, and subsequently confirmed by the surveyors of the French Department des Aux et Forêts.

The problem of the thickness of a glacier has, however, at last been satisfactorily solved by the use of a specially modified form of earthquake seismometer (having a photographic recorder for the vertical component, and a microphonic seismograph), by Dr. Mothe. He first tried it on the Hintereisferner, the thickness of which was approximately known from the work of Hess and Blümcke. The velocity of propagation of the explosion waves, produced by the firing of loudly detonating explosives at the surface, proved to be 3,400 m./s. for the longitudinal waves and 1,600 m./s. for the transverse vibrations, and the echoes recorded by the seismograph indicated a depth of the glacier bed in good agreement with the value of Hess and Blümcke. In February, 1929, Dr. Mothe carried out similar seismographic determinations on

the Great Aletsch glacier, and found near the Condordia hut a depth of no less than 700 metres.

As regards the general results of glacier survey, the following table shows the conditions for one hundred Swiss glaciers in the years 1926 to 1932 :—

Year.	Growing (advancing).	Stationary.	Decreasing (in retreat).
1926	52	3	40
1927	22	7	71
1928	14	5	81
1929	11	12	77
1930	8	12	80
1931	22	12	66
1932	13	7	80

There had been a general advance of the Swiss glaciers in the second decade of the twentieth century, coinciding with an augmentation of the snowfall on the high mountains and a lowering of the summer temperature. The general retreat shown in the above table for the third decade has corresponded with an accentuation of the summer heat, and not with any sensible diminution of precipitation. Hence the essential factor of variation would appear to be the temperature of the summer season. This was indicated long ago by the late Professor Forel shortly before his lamented death, and has now been definitely established, both by the above results and by Dr. Billwiller in a detailed discussion of the subject in a report in the Annales de l'Institut Fédéral Suisse de Météorologie, 1930.

During this third decade the Savoy glaciers of the Chain of Mont Blanc have also been in retreat, but the change has now again arrived. For when the writer was at Chamonix in June and July 1933, the Glacier des Bossons, the Mer de Glace, the Glacier d'Argentière, and the Glacier de Taconnay, all of which he personally visited, were again advancing, a fact confirmed by the Guide Chef, M. Balmat. The retreat of the Bossons glacier had been so great that the lower reach of the icefall, which some years ago had actually come down on to the green meadows of the Chamonix valley, had almost disappeared up its ravine.

Surveys in Switzerland.

The movements of some of the more important Swiss glaciers have been measured during the last three years. The exceptional advance of the Lower Grindelwald glacier has been the most outstanding occurrence. It receded eight and a half metres in 1930, but advanced five metres in 1931 and three metres in 1932. The Rhone glacier, in receding sixteen metres per annum during the last two years, has lost much of its celebrated beauty and also its famous ice cave. It may be remarked before concluding that an average of one hundred Swiss glaciers have been observed every year (varying from ninety-five in 1926 to 108 in 1932). Similar regular work has been carried out on the glaciers of Savoy and Dauphiny, and on those on the Italian sides of the Mont Blanc and Mont Rosa-Matterhorn chains. The total value of this immense glaciological research is beyond estimation, not only in advancing pure knowledge, but in the prevention of disastrous calamities such as formerly occurred with distressing regularity.

A striking instance of the latter beneficent effect may aptly be referred to in conclusion. The shocking disasters in the Vallee de Bagnes of 1818 and 1898, both in the month of June, when lakes which had formed in the Glaciers du Giétroz and Grête-Seche suddenly burst and deluged the valley as far almost as Martigny, caused appalling destruction and loss of life; they are still remembered with fear by the inhabitants of the beautiful valley. In the latter and relatively smaller catastrophe no less than a million cubic feet of water were suddenly let loose. This menace has since threatened time after time, but owing to the constant observation and the construction of siphoning trenches since the year 1899, and their careful supervision and clearning of obstructions, the menace has been averted.

Science and Food.

Sir George Newman, Chief Medical Officer to the Ministry of Health, calls attention in his annual report to a new problem which has arisen through the scientific "treatment" of food. Every factory of any consequence, he points out, is now equipped with its research laboratory and every sort of artifice is being used to "improve" the appearance, colour, taste, keeping qualities, etc., of food. For the most part such artifices are above suspicion and constitute an obvious advance in manufacturing practice, but many of them are open to serious question and are causing some uneasiness among those responsible for the wholesomeness of food supplies. As instances in which there exists a legitimate suspicion that a commercial process may involve a definite risk to health or debasement of nutritive value Sir George cites: the fumigation of food with toxic gases to destroy insect pests; the presence of heavy metals in foods due to the materials or containers used in manufacture and storage; the increasing use of poisonous insecticides and fungicides in agriculture and horticulture; and the introduction of new synthetic colours and flavours.

New Studies of Rainfall

By John Glasspoole, M.Sc., Ph.D.

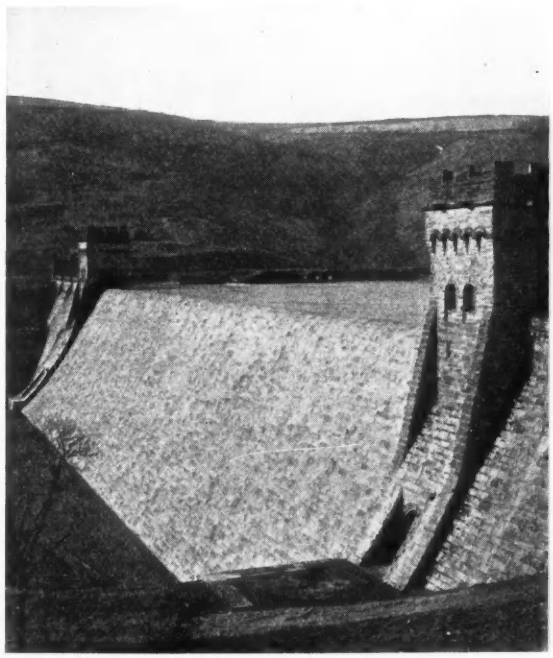
Hon. Secretary of the Royal Meteorological Society.

The systematic study of rainfall is an increasingly important branch of meteorological research. Reliable records are of special value to farmers and to engineers engaged in water-supply and hydro-electric schemes. Dr. Glasspoole urges the need for additional observations, particularly in sparsely populated regions.

THE rain which falls over the British Isles may be regarded as a national asset. Each rainfall record defines this asset for a particular locality. Considerable progress has been made of recent years in defining the fluctuations of rainfall from place to place and their variations with time. A record of these fluctuations is of interest not only to the meteorologist, but over a considerably wider field.

The subject is of practical importance, since for many purposes some forecast must be made, either deliberately or subconsciously, of the probable rainfall likely to be experienced, necessitating reference to the accumulated experience of the past. It is, for example, essential that the agriculturist should know something of the variations he is likely to experience, and of the frequency with which exceptionally wet or dry years will occur. In water-supply and hydro-electric schemes the engineering problem is to utilize to the fullest possible extent the rainfall of wet years or of wet winter months so as to tide over runs of dry years or spring and summer droughts.

Our knowledge as to rainfall experienced over the British Isles is based in the main on the records of voluntary observers, who have been sufficiently interested to set up a rain-gauge. In some cases the record has been kept primarily to ascertain the rainfall day by day, in others the observer desired to know whether his own locality was wetter or drier than some other region, while other observers required some precise information as to the amount of water which could be relied upon for some specific purpose, such as a water supply from the roof of a house or for a mill from a local stream. Fuller use can be made of these records if they are collected and compared at some central office. An enthusiast, the late Mr. G. J. Symons, F.R.S., came forward and commenced this work in 1860, when he founded the British Rainfall Organization. Symons will be remembered as the organizer who arranged for the records at each station to be maintained as far as possible in a similar manner and for records to be started in sparsely populated districts. Dr. H. R. Mill, who became director in 1900, introduced, with striking success, the cartographical methods now in use for defining the variations in the rainfall experienced over the British Isles. In 1919 the accumulated records were acquired by H.M. Government and the Meteorological Office of the Air Ministry assumed responsibility for continuing the work. Shortly afterwards a new series of annual and monthly averages were computed for some 600 stations over the British Isles for the standard period 1881 to 1915. With the preparation of these averages the material became available for the study of the fluctuations of rainfall from a number of aspects.



A striking view of Derwent reservoir which supplies water to Derby, Leicester, Nottingham and Sheffield.

Symons not only did all he could to establish new stations but he also collected records for earlier years. The first known record in the British Isles was maintained by Mr. Richard Townley at Townley, near Burnley, from 1677 to 1703. The next earliest is that from Upminster, Essex, from 1697 to 1716, maintained by Dr. W. Derham. In

the Report of the British Association for 1866 these records are summarized and general values are given for the rainfall over England and Wales for each year since 1726. These annual values have recently been revised and brought up to date, and in addition general values have been computed for each *month* from 1727 to 1932.

An examination of these statistics shows that there are often long periods in which either dry or wet years predominate. A realization of this fact is of importance, since while dry years persist there is often a temptation to undertake elaborate water supply schemes, whereas during a long run of wet years the general public may be lured into a sense of false security as regards adequate supplies.

Frequent Dry Years.

The outstanding feature in the series is the frequency with which dry years occurred between 1730 and 1766. These are confirmed in many instances by early weather diaries. But conditions were not, perhaps, as severe as in 1716 when according to Dr. T. Short, of Sheffield, " thousands of persons passed across on foot, under the arches of London Bridge." This is said to have occurred on September 14th, 1716, following a drought, when a strong west-south-west wind not only prevented the tide from coming in for twenty-four hours, but drove forward the fresh water so that there was only a narrow channel some ten yards wide. This is of interest as presenting the antithesis of the disastrous floods of January 7th, 1928, in London.

Dry years also predominated from 1854 to 1858 and from 1892 to 1908, but the droughts then experienced were not nearly as intense as those of 1730 to 1766. On the other hand, wet years predominated from 1872 to 1883 and again from 1922 to 1932. During the last eleven years the mean annual rainfall over England and Wales has been as much as 110 per cent of the average, but the eleven years 1872 to 1882 were wetter, having a mean of 114 per cent.

The diagram shows the variations in the annual rainfall experienced over the British Isles since 1863. The method used is that employed by Mr. A. A. Barnes in his paper read before the Royal Meteorological Society in December, 1931. Mr. Barnes takes the annual general values and evaluates the accumulated excess or deficiency. The average for the 44 years 1887 to 1930 is regarded as the normal, the rainfall of each year is expressed as a percentage of the normal, the departures from the normal in successive years are added algebraically and the final values plotted. Where the curve rises, the rainfall of the year exceeded the average, whereas when the curve falls the years were dry. The curve demonstrates the recent run of wet years, which has persisted without a break since 1922. Most parts of the country have experienced this run of wet years. There is also a remarkable symmetry in the fluctuations experienced both before and after the year 1908, and this symmetry also occurs in the general values for England and Wales, Scotland and Ireland separately.

There have not only been definite alternations of periods in which dry or wet years have predominated, but for quite long periods wet years have occurred at regular intervals. From about 1868 to 1888 wet years occurred in general at intervals of five years, from 1889 to 1909 at intervals of three years, and from 1910 to 1922 the even years were all wet. This gives a suggestion of regularity, but detailed examinations of long records have failed to bring to light any periodicities sufficiently well marked to be of service in forecasting. Nature seems to have an infinite capacity for suggesting systematic fluctuations and abruptly terminating them. There are numerous examples of isolated " waves," such as that shown in the diagram. The general conclusion is that since previously wet periods have tended to alternate with equally well defined dry periods, a term of years in which dry years will predominate cannot be long delayed. This suggestion is perhaps supported by the existence of a fairly well marked periodicity of 51.7 years, which can be traced in the series of rainfall values back to 1677. On the other hand, it is not legitimate to assume that the symmetry in the fluctuations about 1908 will continue. Mr. A. E. Douglass has devoted considerable attention to fluctuations in the annual rainfall, as determined from sections of trees showing ring growths, especially in Arizona, and he is now concerned with the possibilities of enunciating some law of the sequence of cycles, a very important aspect of the problem.

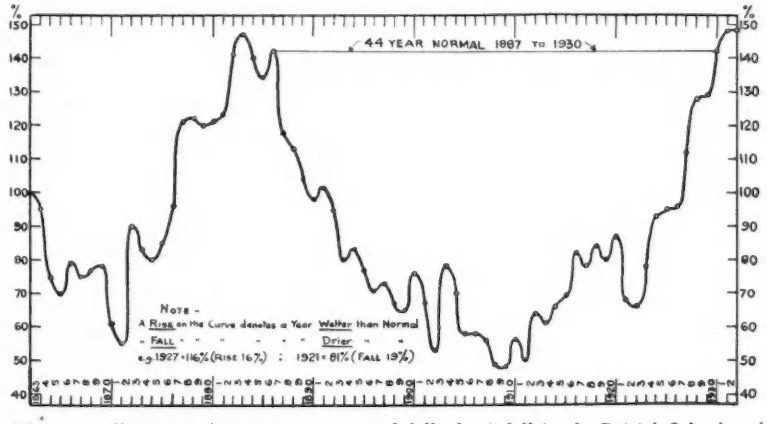
New Progress.

Considerable progress has been made of recent years in defining the average annual rainfall over the British Isles, and numerous maps, on a scale of 2 miles to 1 inch, covering a large part of the country, have been prepared by the British Rainfall Organization of the Meteorological Office. The methods used in the preparation of these maps are set out in articles in *British Rainfall*, 1928, 1929 and 1932, where maps are given showing the distribution over three typical areas, Norfolk, Pembroke and the Tees Valley.

If a number of stations representative of all parts of the British Isles are arranged in order of altitude and the average annual rainfall is also given in each

case, the stations at high elevations would in general rank among the wettest. There would, however, be many anomalies. Thus Seathwaite, often referred to erroneously as the wettest spot in the British Isles, has an average rainfall of as much as 129 ins., although the altitude is only 400 feet.

In any small area the relation between the rainfall and the configuration is well marked, but the important factor is not the elevation of the region, but rather the extent to which air is forced to rise over the adjacent mountains. The rainiest regions of the world, the Khasi Hills of Assam, the Western Ghats of India, the volcanic mountains of the Hawaii Islands, and the Cameroons of West Africa, are all found where a warm moist wind blows steadily against a range of mountains. Nearness to the sea, especially to the south-west, *i.e.*, in the direction of the prevailing wind, is another factor of importance. Clearly when moist air has passed over one mountain range any subsequent mountains are likely to be less effective in producing rain. The large rainfall at Seathwaite is due to the vertical component produced when air is forced over Great Gable and other mountains in the neighbourhood. As would be expected, the rainfall is found to be greater nearer the summit of Great Gable.


44 YEAR NORMAL 1887 TO 1930
NOTE -
A Rise on the Curve denotes a Year Wetter than Normal
" Fall " " " " Drier " "
e.g. 1927 = 116% (Rise 16%) : 1921 = 81% (Fall 19%)

The curve illustrates the percentage rise and fall of rainfall in the British Isles based on the forty-four year normal from 1887 *to* 1930.

It is also found that mountain ranges at right angles to the prevailing wind receive more rain than similar mountain ranges which run in the direction of the prevailing wind, since the former prove a greater obstruction to the moisture-laden winds. Thus Pendle Hill and the Cotswolds are not as wet as they would be if they ran from south-east to north-west. Valleys which face the sea to the south-west have a small rainfall for a longer distance up them than similar valleys facing other directions. In most years the largest rainfall totals are experienced either on Snowdon, in the English Lake District, or at the head of the River Garry in the Western Highlands, while the smallest totals usually occur along the east coast of Great Britain, especially in the neighbourhood of the Thames Estuary and the Wash. The absolute range for any calendar year is from about 10 ins. in 1921, recorded at Margate, to about 250 ins. in 1928 at the Stye above Seathwaite.

There are obvious difficulties in arranging for continuous observations at high elevations, so that in general the rainfall of the summits of mountains can only be inferred from the records at the nearest stations. One outstanding exception is that of Ben Nevis, where the records maintained at the observatory (4,406 feet), showed that the average annual rainfall was about 165 ins. This subject was considered in some detail recently, when it was concluded that the average annual rainfall reached 200 ins. over small areas both on Sgurr na Ciche, above Loch Quoich, and on Snowdon, and that these areas are the wettest in the British Isles. The maximum average rainfall on Sca Fell or Scafell Pikes is probably about 185 ins.

It is found that the distribution shown on the average annual map of the British Isles is reproduced fairly closely in the case of all rainfall maps for individual years, and even on most monthly maps. This family relationship is due to the control, on the distribution of the rainfall, which is continually being exerted by the configuration of the land. In order to study the variations in the rainfall year by year the annual rainfall at each station is expressed as a percentage of the average annual amount. When these percentages are plotted, the distribution on each map is a simple one, being independent of the local configuration of the land. Thus while the annual totals recorded at Ben Nevis Observatory were more than twice those at Fort William, the annual percentage values were similar. This was the method employed in the preparation of the series of annual maps published by the Royal Meteorological Society in the " Rainfall Atlas of the British Isles " and in the series of maps showing the rainfall of each of the

eleven decades during the period 1820 to 1929. A study of the changes in the distribution either from year to year or decade to decade suggests little regularity, although it might be found that belts of excessive or deficient rainfall moved across the country in a systematic manner, if the maps were viewed rapidly in sequence as in a cinematograph. The changes in the amount and distribution of the rainfall from year to year and decade to decade have been related both to changes in pressure distribution and to changes in wind direction.

Distance from the Sea.

The mean deviation of annual rainfall, when expressed as a percentage of the average annual amount at that station, has been shown to vary in a regular manner over the British Isles. The largest values occur in the Midlands and to the south-east of the British Isles, while the smallest values occur along the north-west coast of Ireland. The variation is apparently a measure of the insularity of the climate, the largest deviations occurring in the centres and south-east of the land masses, whilst the coastal regions, especially the north-west, have small deviations. The influence of proximity to the continent is clearly shown, the general distribution being a resultant of continental and sub-continental effects, depending primarily upon distance from the sea.

It is convenient to express the extremes of rainfall which have been recorded in any number of consecutive months as percentages of the average annual rainfall. Extremes have been extracted for numerous stations in the British Isles with complete records since 1870, and it was found that the series of percentage values for all stations were similar, although the extremes have not occurred simultaneously over the country. A study of the mean percentage values at forty stations, representative of all parts of the British Isles, shows that the rainfall of any group of four consecutive months at any station has varied approximately between 10 and 70 per cent of the average annual rainfall at that station, and every group of ten months between one-half and four-thirds of the annual average. Observations also show that while twice the annual average may occur in as short a period as 16 months, it may be spread over as long a period as 30 months. These percentage values serve as a criterion for the comparison of the rainfall of any recent period, and they are the best available indication as to the rainfall which can be relied upon in any part of the country.

For statistical purposes, the definition of a rain-day is " a day on which .01 in. or more of rain is recorded," smaller amounts being referred to as " trace." Records of the annual number of rain-days present features distinct from the corresponding rainfall totals. In the first place the number of rain-days shows a much smaller variability from year to year than the corresponding rainfall totals at all stations in the British Isles.

This applies both to the variations of average monthly and annual values from place to place, and also to the variation of average monthly values at any one place. The second difference is that, even at stations with the same rainfall, the average number of rain-days increases from the south-east to the north-west of the British Isles. This is due to the fact that many depressions, which normally pass to the north-west of the British Isles, do not extend their influence over the south-eastern half of the country. The average annual number of rain-days at any station is controlled by the geographical position of that station, *i.e.*, whether to the north-west or south-east of the British Isles. In fact there is a very close relationship between the average number of rain-days and the perpendicular distances of the stations from a line drawn through the extreme south-east of Kent in a south-west to north-east direction.

That the number of rain-days is practically independent of the actual rainfall is confirmed by the records at Ben Nevis Observatory and at Fort William, for while the average annual rainfall was 165 ins. and 78 ins. respectively, the average number of rain-days was 263 and 244. Rain falls much more heavily on Ben Nevis, so that the number of days with larger amounts is much greater. At Fort William there are 52 days with .50 inch or more on the average each year and these contribute 62 per cent of the rainfall, whereas at Ben Nevis there are 106 days with .50 inch or more and these contribute as much as 82 per cent of the total rainfall.

Need for More Records.

In spite of the generalizations which have already been enunciated as to the distribution of rainfall over the British Isles, additional records are still desired. More observations of rainfall are needed than for other meteorological elements, since rainfall varies so much from place to place. The maximum rain which is likely to occur in short intervals of time over small areas is of importance in many engineering problems, and for such purposes a close network of stations is essential. Additional observations are especially required in the more sparsely populated regions of the British Isles.

How Can We Organize Agriculture?

By Sir Daniel Hall, K.C.B., F.R.S.

*The organization of agriculture is a pressing problem. What alternatives are there to the Russian plan—methods which will ensure economic efficiency and yet give play to individual initiative and enterprise? This is the question discussed by Sir Daniel Hall, who asks if the scientist is no longer wanted.**

It used to be said that the greatest public benefactor was the man who could make two blades of grass grow where one grew before. Not so to-day, when the nations are considering agreements to restrict output and even destroying the products of the soil. The man of science must take up an apologetic attitude at the present time with regard to agriculture. For two generations he has been entreated to make the land more productive and to reduce costs; but as an American professor of agriculture writes to me: "Ten million acres of cotton and some thousands of tobacco have been ploughed under. The latest move is the killing of some five million pigs weighing under 100 lb. and the slaughter of some 200,000 prospective mother sows. If this will bring national prosperity I have wasted my life." The man of science may be forgiven if he concludes that he is no longer wanted and may retire to his ivory tower, but whatever food for irony the world spectacle presents he will not be allowed to enjoy it in detachment, for if the deluge comes he will be swept down with the rest.

A Paradoxical Situation.

What are the causes of this paradoxical situation? In the first place, the agriculture of the world is predominantly a peasant industry. In Great Britain, we have developed in such an exceptional fashion (only 6.6 per cent of our workers are engaged on the land) that we do not always realize how much we stand apart. But in France 41 per cent, in Germany 34 per cent, in Czechoslovakia 40 per cent, in Poland 76 per cent, in the United States 26 per cent are so occupied. At the extremity of the scale, in the East, the proportion of the population engaged upon the land may rise to 80 per cent, and in large districts in China even to 90 per cent. Taken alone, these figures do not tell the whole story; more significant is the fact that they are mostly made up of single-handed independent occupiers of land, employing only their own labour and that of their family. In all the European countries except Holland, the independent holders of land outnumber the paid labourers.

The typical English farm is one of about two or three hundred acres carrying half a dozen or so hired labourers. There are, of course, capitalist farms, often of large size, in all countries, as for example the great demesnes of eastern Europe, though the whole trend of policies since the war has been to break these up into single family units.

Science and Farming.

The advent of science has enormously strengthened the economic position of large-scale capitalist farming, particularly the recent progress in power machinery, of which the full effects have not yet been realized. Efficiency of production has advanced to a degree difficult of estimation; indeed, were agriculture, like any other industry, governed only by the free play of competition in the pursuit of profits, the family farm would long ago have been displaced. But two opposing factors have been at work; in no old settled country is land a free commodity; custom, even laws, tend to perpetuate the old divisions of the land, and the capitalist can rarely buy an area for extensive farming as he can buy a factory site. Despite the increased use of machinery, manual labour is still a large factor in agricultural production.

A century ago the factory did not all at once displace the hand loom, and in the case of agriculture the solitary worker has the additional advantage in the struggle that he is at least producing food for his family. But the final outcome cannot be in doubt; organization with capital, power and science at command, in other words the machine, must win, provided free competition is allowed to rule. State organization of agriculture in some form has become inevitable; many branches of farming in Great Britain would perish if they were not "nursed." The question remains, what form shall the organization take?

We have one example before us in the Russian plan. What alternatives are there, methods that will give play to economic efficiency and yet be tender of the initiative and enterprise of the individual? Can we eventually transform the social structure of the countryside without beginning by breaking it? In the organizations that have been set up to bring the producers of each commodity into selling corporations, we see the beginnings of such a system. It is perhaps not generally realized how fundamental a change in the conduct of the agricultural industry of Great Britain has been wrought by recent legislations.

*Alexander Pedler lecture of the British Science Guild.

Provided a certain proportion of the producers of a given commodity demonstrate their case to the Minister of Agriculture, he can give to their combination a monopoly of the right of sale; no producer outside the combination may sell to the public, all the members of the combination must sell through it. These powers of combination and control can be extended to any intermediary manufacturing process intervening between the producer and the retailer; prices will be fixed and production regulated by the limitation the corporation will put on the amounts it will sell for each producer. The power to determine internal prices will ultimately depend on the regulation of the volume of imports and the duties that are to be imposed. The Government has undertaken to apply one or other of these measures as a necessary part of the new policy to stimulate home production. The object is to ensure stable prices, no longer subject to the devastating influence of foreign competition, often forced and illegitimate. In brief, producers and processors of any agricultural commodity can now form a guild, which will be endowed with a monopoly, and directly or indirectly will exercise complete control of all production for sale.

The organization aims at removing the great criticism that can be levelled against the agricultural community, that its average practice is much below the performance of the best farmers. In future, if a farmer is to sell pigs at all he will have to forego many of his preferences for particular breeds or methods of feeding, and to bring forward pigs that have been bred and fed on the lines laid down by the corporation, on instructions that are the outcome of knowledge and experiment. Hitherto such knowledge, in so far as research has made it available, has been left to permeate by means of advice, but the results have always been slow and imperfect because the economic advantage of the improved method is generally of an order that is easily obscured by the accidentals of farming, especially as accurate recording has not been common practice. Such a co-operative but controlled organization is the only one I can see that can compete with the Russian plan of complete unification of the industry, and at the same time retain the essential freedom of the individual.

Taking a Long View.

Such corporations will be able and, if they are to be acceptable, will have to enforce certain reformations in their particular industry which may not be of any great profit to the farming community but may be required by the consumers. To state one such case, it is possible to free the dairy herd of the country from bovine tuberculosis, which would not only mean greater safety to the health of the general population but also would cheapen the production of milk by reducing one of the considerable items of cost—the relatively short life of the average dairy cow. In so far as the milk producers as a body have to be paid for the costs of production, whatever they may be, no gain to them would accrue by the elimination of tuberculosis; the new cheapness would be passed on to the consumers. The controlling corporation, which must consider the interests of the general public because from them it derives its monopoly and price-fixing power, can embark upon such a scheme. It can take the long view and adopt a scheme which despite its prime cost will ultimately both cheapen and improve the product.

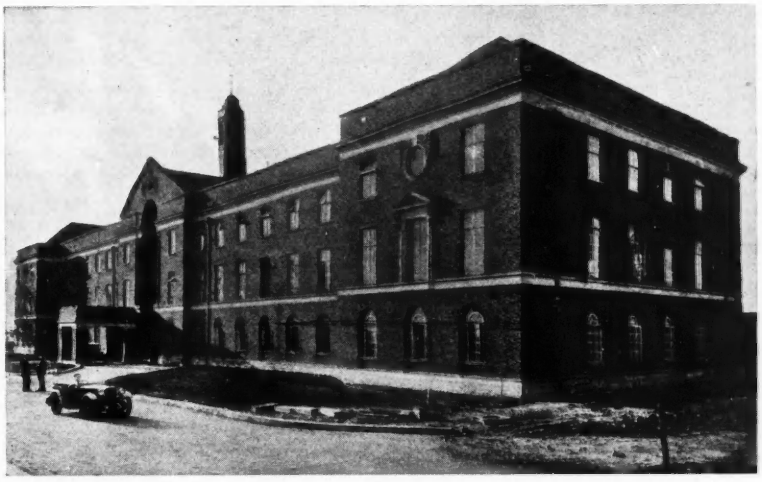
Wise Planning.

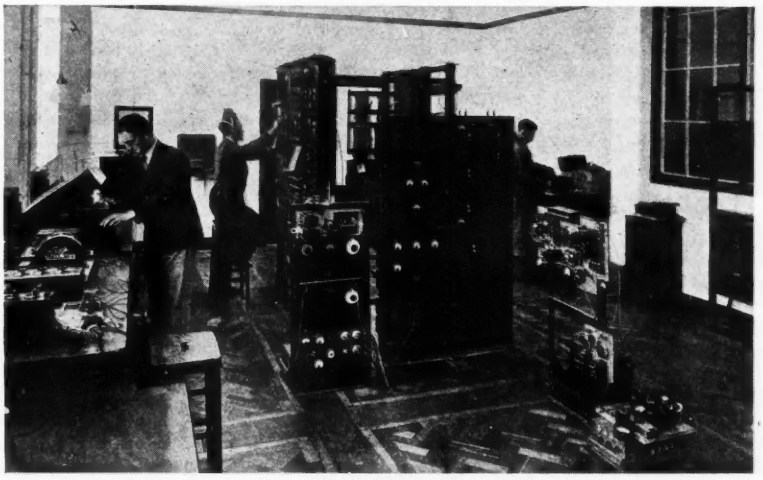
It is indeed a necessary part of the new system, if these corporations are to become efficient elements of the national economy, that there should be some superior organization planning and directing their work in the national interest. Otherwise the corporations may easily degenerate into guilds concerned only in maintaining a price-level that will enable their members to carry on automatically on the old lines. It would be for this central body, personified in the Minister of Agriculture, to decide which branches of the agricultural business in Great Britain should be encouraged to develop and which should be subjected to the brunt of economic pressure, whereby they would be either transformed or abandoned. To take an example, it is inevitable that there will be, in the future as in the past, strong pressure from an important section of farmers to maintain a remunerative price for wheat. Now while wheat may be almost a necessary element in the current rotation on certain types of English soil, it should be regarded as a by-product rather than as the main object of the farming system. For our farming can and should pick and choose, specializing upon the higher grade products rather than on the primary commodities like wheat.

The fundamental truth is that, whatever may be the increased efficiency of production that science has put at man's disposal, it will be still insufficient to satisfy the reasonable demands of the population, when each in turn is producing some commodity that can be freely exchanged. It is precisely in this difficulty of exchange that the plight of the agriculturist resides, all the world over, and if we take a world point of view, we see that agriculture cannot lift itself out of its depression by its own efforts.

RESEARCH AT THE POST OFFICE.

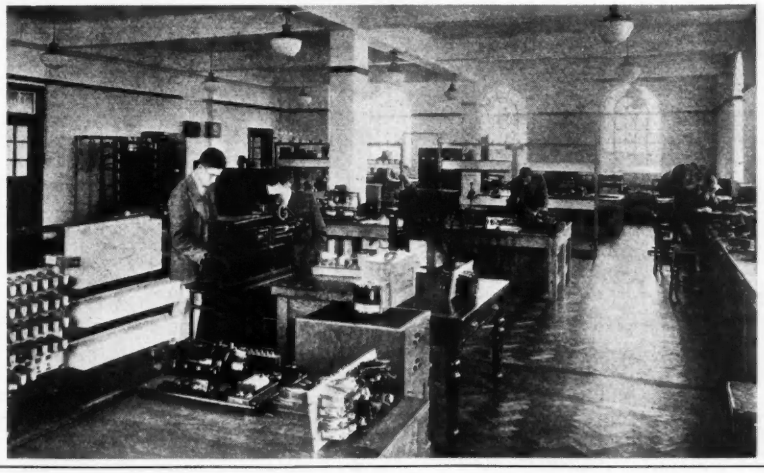
The new Post Office Research Station at Dollis Hill, London, was opened by the Prime Minister last month. Special attention is being paid to the improvement of the telephone service, among the latest developments being a microphone and loudspeaker equipment to replace existing instruments in the home.





These photographs, reproduced from our contemporary "The Electrician," show (above) an exterior view of the new buildings. On the left is the ultra-short wave radio laboratory. This is of special interest in view of the television transmissions which the B.B.C. is to send out on ultra-short waves, thus obtaining much greater detail in the pictures.

On the right is the signalling apparatus used in research on the design of new telephone exchange equipment. It has recently been employed to test "voice frequency" on long distance lines. These tests are expected to result in a general speeding up and improvement in trunk telephone services.



Book Reviews.

A Diary of the Voyage of H.M.S. "Beagle." By CHARLES DARWIN. Edited by NORAH BARLOW. (Cambridge University Press. 21*s*.).

In later years Darwin described the voyage of the *Beagle* as by far the most important event in his life; he declared that it had determined his whole career and had enabled him to do whatever he had done in science. "Looking backwards," he wrote, "I can now perceive how my love for science gradually preponderated over every other taste. During the first two years of the voyage my passion for shooting survived in nearly full force, but gradually I gave up my gun more and more, and finally altogether, to my servant, as shooting interfered with my work, more especially with making out the geological structure of a country."

Darwin was twenty-one when, in the summer of 1831, he first received an offer to accompany Captain Robert Fitzroy on his surveying voyage. While awaiting the day of sailing at Devonport, he wrote: "It is difficult to mark out any plan, and without method on shipboard I am sure little will be done. The principal objects are first: collecting and observing and reading in all branches of Natural history that I possibly can manage. Observations in Meteorology, French, and Spanish, Mathematics, and a little Classics, perhaps not more than Greek Testament on Sundays."

The complete text of Darwin's journal is here published for the first time, since about one third of the MS. diary was omitted from the well-known versions of the journal—the first and second editions of the *Voyage*. The book is ably edited by Darwin's grand-daughter. It is based on eighteen pocket-books in which Darwin made the first rough pencil notes of his observations and impressions during the voyage. In the later notebooks it is interesting to see the increasing space devoted to geological sketches and data, and while less is given to general description: "There is nothing like Geology," Darwin wrote to his sister. "The pleasure of the first day's partridge shooting or the first day's hunting cannot be compared to finding a fine group of fossils which tell their story of former times with almost a living tongue."

The origin and growth of Darwin's evolutionary beliefs has been much discussed. Mrs. Barlow writes: "We know that Darwin left England in 1831 with unshaken belief in immutability and the creationist point of view. We learn that he took the first volume of Lyell's *Geology* with him, and that the second volume reached him in South America. In 1837, less than a year after his return to England, he was completely convinced of the deep significance of geographical grouping and of the transmutation of species, and had set himself to seek out the laws of change." In a diary in which Darwin recorded the outstanding events of his lifetime, he wrote on the opposite page to the general entries of 1837: "In July opened first notebook on 'Transmutation of Species.'—Had been greatly struck from about month of previous March on character of South American fossils—and species on Galapagos Archipelago,—These facts were the origin (especially latter) of all my views."

The Diary throws interesting light on the character of the captain of the *Beagle*, Robert Fitzroy, who was a devout believer in the first chapters of Genesis, and whose almost fanatical views seemed to develop in fervour as the voyage progressed. It is interesting to know that Fitzroy invited Darwin to join the ship because he desired the services of a naturalist who would gather information "which would ultimately confute the geological sceptics who impugned the strict and literal truth of every statement contained in the Bible." Fitzroy's admirable work as a surveyor on the voyage appears to have received scant attention, although, before his suicide in 1865, he had become a Vice-Admiral and head of the Meteorological Department of the Board of Trade. Through his efforts, the *Beagle* returned to England with no less than eighty-two coastal charts, eighty plans of harbours and forty views for the Hydrograph Department of the Admiralty.

Mrs. Barlow is to be congratulated on this admirable presentation of her grandfather's diary, the value of which is greatly enhanced by her notes and preface. The frontispiece is the reproduction of a drawing of Darwin as a young man, four years after the return of the *Beagle*. It was discovered in 1929 by Professor Seward in a portfolio of Darwin relics in the cellar of the Botany School at Cambridge. There are also diagrams of the *Beagle*, a map of the southern portion of South America, showing Darwin's principal inland expeditions, and a map showing the track of the ship round the world.

Brothers of the Snow. By LUIS TRENKER. Translated by F. H. LYON. (Routledge. 10*s*. 6*d*.).

The author combines the occupations of an Alpine climber and a film producer. When less than twenty he became one of the leading guides in the South Tyrol. During the war Trenker served in his native peaks, and he writes vividly of war in the Dolomite heights where there were the additional dangers of avalanche and precipice. His knowledge of mountain scenery eminently fitted him for the production of films, the most outstanding of which was his reconstruction of the Matterhorn disaster of 1865. Trenker played the part of Carrel, the Italian guide whose party was beaten by Wymper's in the race for the summit. The chapter describing the making of this film, and recalling the tragic events on which the story was based, is perhaps the most graphic. The author recalls how in 1861-5 Edward Wymper made seven attempts to climb the Matterhorn. Six were made from the south side, the Italian guide Carrel being his companion on almost every occasion. In the meantime the Club Alpino Italiano was founded and Carrel was then reproached for having helped an Englishman to conquer the Matterhorn, whose western summit is in Italy. Carrel gave way and, strongly supported by prominent Italians, made an attempt to climb the peak via the southern ridge. Wymper learned of the secret expedition by chance. He determined to ascend the mountain from Zermatt via the Swiss ridge. He was accompanied by Lord Francis Douglas, the Rev. Charles Hudson, Mr. Hadow, a young climber of nineteen, and three guides. Carrel had a start of two days. Wymper set out on July 13th, 1865. The summit was reached on July 14th. But Douglas, Hudson, Hadow and Croz, the chief guide, fell on the descent and lay dead among the crevasses of the Matterhorn glacier.

This is the story which was retold on the screen. Each of the actors covered 150,000 feet uphill and down. "Then," Herr Trenker remarks with pardonable cynicism, "some 'love scenes' were tacked on to the mountain photographs in a Berlin studio. The climbers were not enthusiastic about them, but the film company was, very. It is not easy to make films as one wants. Others have a voice in the matter. The film company received a gold medal for 'The Fight for the Matterhorn' because, according to a vote taken by a film magazine, it was the second best commercial success of the year!" The author naively adds: "A director of the film company actually paid us a visit while we

were at work at Zermatt. He stayed two days at the Hotel Victoria and then went back to Berlin. He still has the gold medal ! "

The spirit of Herr Trenker's stirring and beautiful book is reflected in the sentence with which this chapter closes : " It was autumn. We were resting in a green, safe, comfortable valley. Our work was over, but our eyes returned with longing to the peaks and ridges of the Matterhorn, for they are so near the clouds and the sky." It is a story of great courage and daring, told with the modesty of a real adventurer.

A Fossicker in Angola. By MALCOLM BURR. (Figurehead. 5*s*.).

Dr. Burr is equally distinguished as a geologist and as an entomologist, and he is probably more familiar with Russia and the Balkans than most living writers. He is perhaps best known as the author of *In Bolshevik Siberia* and as the translator of P. S. Nazaroff's remarkable work *Hunted through Central Asia*, the story of a distinguished Russian scientist's escape from the Bolshevists. It is interesting to note that the journey described in the present book was made in Nazaroff's company. In a preface Mr. H. V. Nevinson, the war correspondent, recalls Dr. Burr's invaluable service during the war, when he undertook the task of organizing Macedonian labour for the army, as well as recruiting and commanding a battalion of Serb volunteers. The author spent two years prospecting in Africa, spending the greater part of the time in Portguese Angola. Over eight thousand Orthoptera specimens, representing six thousand species, were collected in Angola and the Luena Valley ; about 100 species are new to science.

Travel in Angola is not as difficult as might be supposed. Although the country is poor in railways it is rich in roads, for the Portugese have laid out some twenty-five thousand miles of track, mostly with firm, even surface over which their cars and lorries make good going. Most of the cars are of American make, though the author noted that British tyres have a good reputation. " Angola has not yet been vulgarized, tourist-ridden, nor infected by the cinema." Travelling in the valley of the Luena, one of the upper tributaries of the Zambesi, the author noted the presence of the Giant Hornbill, or rainbird, as big as a large turkey with a beak nearly as long as the body. These grotesque creatures are valuable as scavengers, and the natives respect and preserve them. Angola is rich in magnificent waterfalls, which seem to " drop into the ground." They occur in plains and simply disappear, dropping away to a lower level, the ground at the sides falling almost imperceptibly with no marked cliffs.

Dr. Burr has written an absorbing book. It will appeal not only to travellers, but to all who have an interest in the little-known geology and entomology of Angola. The author has a sense of humour, which he applies effectively to some aspects of life in the Bush. The production of the book is neat, and the price is within the reach of every purse.

The Land that God Gave Cain. By J. M. SCOTT. (Chatto and Windus. 12*s*. 6*d*.).

This is the story of the late H. G. Watkins' expedition to Labrador, which immediately preceded his more famous Arctic Air Route Expedition to Greenland, described in the same author's *Northern Lights*. Mr. Scott was Watkins' sole companion for some time on the Labrador expedition, and he is therefore able to write intimately of the late explorer, of whom he says : " With Watkins the most serious objectives always held something to laugh about, and in their achievement they suffered nothing from his lightheartedness." In an introduction, contributed before his death, Watkins explains how the expedition came into being. He had been asked in 1927 to precis an account of the dispute between Newfoundland and Canada over the position of the Labrador boundary. Up to the time of the dispute no one had taken much interest in the " land that God gave Cain," but now people began to hear about its great potential wealth and wished to learn more about it. The coast was badly mapped and the interior almost unknown. The most interesting part lay about 450 miles inland in the Grand Falls district. From here explorers had brought rumours of " unknown rivers and huge undiscovered waterfalls." The nearest point was a settlement about 90 miles inland from the Atlantic coast, and situated at the head of Lake Melville at the mouth of the Hamilton or Grand river. It was at this point that Mr. Watkins planned to have his base. His main objective was to explore the country with a view to an air survey in the future which, he says, would be the only satisfactory way of mapping Labrador. The plans of the expedition included a journey into the country to the north of their base, mapping the rivers and lakes and incidentally hoping to find lakes suitable for use in an aerial survey. Secondly, they aimed at a journey into the country south of their base, if possible as far as the Gulf of St. Lawrence. Third, to make a journey up the Hamilton river to the Grand Falls district and to map the Unknown river and falls. The fourth object was to carry out a journey to the boundary in the Attikonak river district and to follow this boundary, mapping it for as great a distance as possible. Except for the last journey, all the objects of the expedition were achieved. Mr. Watkins points out that Labrador is a particularly difficult country in which to travel, since it is covered with forests in which, however, there is very little game. This means that on a long journey food has to be taken from the base.

Mr. Scott gives a graphic account of the expedition, dealing with lighter episodes in a humorous way. There are many excellent photographs.

Limitations of Science. By J. W. N. SULLIVAN. (Chatto and Windus, 7*s*. 6*d*.).

Mr. Sullivan's little book deserves and will attract the much larger public which desires to know what science has done, and where she now stands, rather than her limitations. It gives this philosophic introduction with admirable balance and with a breadth of knowledge which never obtrudes the unimportant, and puts in due perspective the great turning points. Among the multitude of popularizing books which aim at explaining the scientific outlook at the present day, there is probably none which does it with more certain touch, with more clearness and simplicity of thought and diction, and with more impartiality between the different aspects of scientific work. Mr. Sullivan's interest in music adds an additional charm, for he often explains that there is a beauty in a certain mathematical and physical theory which gives it an aesthetic appeal like a rhythm or a harmony.

The chapter, which oddly gives its title to the book, comes sixth among eight. The earlier chapters are mainly historical, and trace the building up of the structure, from its Babylonian and Egyptian foundations, by the hands of the Greeks until in the seventeenth century the full-grown master of science appears in the world in the person of Galileo and Newton. Mr. Sullivan does justice to the service of the scholastics in keeping the rational spirit alive, but he will not allow that any one has a

claim to be a perfect man of science before Newton. Even Galileo fell a little short of the ideal by not realizing the necessity of confirming mathematical deductions by experiment until his opponents compelled him to do so. From the great synthesis of the seventeenth century the story is traced in a few bold strokes down to the transformation scene in our own times, when, as Mr. Sullivan says, we are called upon to judge the universe by the electron and not the electron by the universe. He fixes quite rightly on the discovery of the movement of light by Römer in 1675 as one of the most crucial points. This, it will be remembered, is rather more than a decade after Newton had made up his mind on his greatest problems. The subsequent analysis of light, and its correlation with other forms of radiation, have given us the present revolutionary and unstable conceptions of the physical universe in which everything seems highly speculative and uncertain, except that in the infinitesimal something has been discovered which may form a link with the evolution of life.

It is here that Mr. Sullivan wisely takes up a non-committal attitude. The biochemist presses on his researches in the hope that they will reveal in living things more and more of the laws which are common to them and inanimate nature. But Mr. Sullivan concludes, in agreement with Dr. Gray in his recent address to the British Association, that new concepts will be needed peculiar to biology itself, and it is because these have not been formulated that the science of life has not yet assumed the dominating position which is its due. "The richer insight into the nature of living matter will throw the properties of dead matter into a new perspective." The effort to combine the two has so far been made only from the other end, but it will, Mr. Sullivan thinks, be replaced by something like Dr. Whitehead's notion of an organism. He does not press or elaborate this point, and preserves throughout his attitude of open-minded judgment. But it is clear from his concluding words that a synthesis under biology as the leading science would most commend itself to him, because in that way the science of mind would take control.

Mediaeval Studies. By WRAY HUNT. (Fenland. 6*s*.).

Many aspects of mediaeval life are reviewed in this entertaining study which is particularly suitable for use in schools. The author sees the Middle Ages as a time of "forced experiments"; on the one side was a rigid theory of life and social relationships; on the other a mass of men and women striving to adapt their lives to that theory, but in fact adapting the theory to life. This theory was one of the most complex that the human mind has constructed, and the author compares it not ineptly with the caste theory of Hinduism. It was based upon a carefully worked out series of complimentary rights and duties each dovetailed into each other. We see this on the manor, where both the lord and the villein had their rights and corresponding duties; and in trade, with its complex doctrine of "just price." All these rights were related to a theological standard: "if a man neglected the duties imposed upon him by God, he must encounter the direct intervention of God." As the author points out, any movement in social life, any new method of trade, had to be fitted into this elaborate scale of rights and duties or it was immediately denounced. Mr. Hunt sees the cause of the breakdown of the Middle Ages in the fact that the ideals were so high that men failed to live up to them. But some of the ideals were in themselves unsatisfactory: political feudalism never worked; the king in practice was powerless because the theoretical subordination of feudal noble to king could not in practice be sustained; the gild broke down because its theories, fixed by centuries of comparatively stagnant commercial conditions, would not adapt themselves to conditions born of the Renaissance with its restless search for new ideas; the mediaeval church broke down because its standards of life fell far below its ideal, "and men lost faith in a system which said one thing and did another."

Modern Mysteries of Science. By H. GORDON GARBEDIAN. (Selwyn and Blount. 18*s*.).

A Book of Scientific Discovery. By D. M. TURNER. (Harrap. 7*s*. 6*d*.).

Professor Charles Singer, who contributes a foreword to Dr. Turner's book, stresses the fact that the true nature of science, like all forms and results of living activity, can be discerned only when its evolutionary history is known; the past and the present are insolubly one. This is the author's theme. She shows that although new facts are revealed from day to day, no discovery is an isolated event; it is the result of a slow growth, nourished from many sources and having its root deep in the past. A modern discovery depends upon the labours of bygone generations, so that we cannot understand the present without some knowledge of the past. Dr. Turner shows how some part of our present scientific knowledge has grown. Commencing with some characteristics of mediaeval thought—early chemistry, the first printed books, the revival of learning—she deals with the beginnings of modern astronomy, the foundations of the study of magnetism and the discovery of the circulation of the blood. A chapter is devoted to science in the Industrial Revolution, and another to science as a factor in social change, in which such aspects as the change in agriculture, the drift to the towns and the growth of a public health policy are considered; and in a concluding chapter the author discusses the place of science in modern life.

Mr. Garbedian pictures the march of science in many fields, and has woven them into a fascinating picture. His style may be too "popular" for every taste: some of the chapters are entitled: "King Power Looks to New Worlds to Conquer," "Einstein, Universe Maker," "The Vagabonds of Space, Meteors and Comets," "Is the Sun Destined to Die?" But the author has tackled an ambitious plan in a capable way, and the book is very readable.

South African Adventure. By DOROTHY UNA RATCLIFFE. (Country Life. 10*s*. 6*d*.).

The author of this book travelled five thousand miles in a motor caravan. Her book is described as "an enchanting blend of fact and fancy, with beautiful word pictures of South African scenes." Here is one of Miss Ratcliffe's word pictures. "Think of the noisiest things you can—mid-day traffic rolling down the Strand, the machinery in some great power house, the incoming tide along a rocky shore. None of them were noisier or more continuous than the frog colony in the veldpool. Imagine several thousand swing doors creaking with an occasional 'tuckle, tuckle,' then you have a vague idea of what the din of that veldpool was like. Rumour says that the Laird snores, and for once she is no lying jade, but his best effort was entirely obliterated by those frogs. Perhaps they were holding a revival meeting, perhaps a presidential campaign was in full swing, perhaps a Bactrachian choral was being performed. Whatever was going on, I swear by the shade of Aristophanes it was the rowdiest pool by whose rim we have ever tried to sleep." Miss Ratcliffe's style is marred by a heavy whimsicality; she displays more agility with the camera than with the pen.

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